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INTERNATIONAL CONTROL OF ATOMIC ENERGY (2)

WHILE, as Prof. M. L. Oliphant has pointed out (*Nature*, May 25, p. 679) in reviewing the proposals of the Lilienthal Board for the international control of atomic energy, countries whose interest in the peaceful production of power by nuclear methods is more direct than that of countries like the United States richly endowed with coal and other sources of power, may give somewhat different emphasis to some of the points raised, there can be no dissent as to the urgency of the whole problem. If political dilatoriness and self-seeking lead to obstruction and lack of agreement, the Lilienthal proposals and any like scheme may, as Prof. Oliphant remarks, instead of saving the world, have precisely the opposite effect. It is therefore encouraging to note that both the British and Canadian delegates on the Atomic Energy Commission have already signified the support of their Governments for the general principles of the American scheme based on the work of the Lilienthal Board.

It is at this stage that the technical and political aspects merge into the ethical plane ; the moral issues raised by the utilization of nuclear energy are the main concern of the report of a commission appointed by the British Council of Churches*, with Dr. J. H. Oldham as chairman, and including among its members Sir Walter Moberly, Prof. A. D. Ritchie and Mrs. J. L. Stocks. This report was the first considered statement by a representative group to appear in Great Britain, although it has been followed by the statement from the Atomic Scientists' Association, which includes as one of its aims the interpretation of the implications of the release of atomic energy to other men of science and to the general public. The report from the British Council of Churches has little to say on practical policy, but seeks to determine the principles on which policy should be based. In particular, it challenges men to free themselves from the tyranny of habit and of accustomed ways of thinking.

The Oldham Commission, as it may be termed, endeavours to keep in balance the two aspects of the release of atomic energy, which it points out is the culminating point of a process of continuously increasing control of the forces of Nature which has been proceeding for two or three generations ; it does not so much present us with new problems as make more acute and urgent problems already before us for which a solution would in any event have been imperative. Society is now confronted with no less than an immediate threat to the continuance of civilization ; and unless a war with atomic weapons can be prevented, the use for peaceful purposes of the hitherto unimagined sources of power now placed at the disposal of mankind loses all importance. Before men have learned to control wisely for human good the powers which they already possess, they have had given into their hands, for good or evil, powers of infinitely wider range.

* The Era of Atomic Power. Report of a Commission appointed by the British Council of Churches. Pp. 84. (London : Student Christian Movement Press, 1946.) 2s. net.

Of the political and social consequences of the new discovery, the Commission observes that atomic energy is a force too powerful and dangerous to be left uncontrolled in private hands; and that unless, and until, effective control of weapons of mass destruction is established, every State will have to reckon with the possibility of a completely devastating attack made without warning, and in consequence a nation may be forced to entrust to its Government the power of immediate attack or retaliation. Again, apart from the indirect consequences involved in such a state of preparedness, the atomic bomb constitutes a peculiar threat to the urban society which is the outstanding characteristic of modern civilization. There may well also be important and far-reaching psychological effects of the intensification of the feeling of insecurity which the atomic bomb has brought; and while the Commission recognizes the need for swift action in the political field, it believes that a real solution of the difficulties can be found only at a deeper level than that of political arrangement.

The substance of this report and its specific contribution to the debate are contained in the four chapters in which there are successively discussed the choice before society, the problems of power and law, power and the international community and science and society. A brief analysis of social engineering and planning in relation to human progress and of the contrasted attitude of withdrawal from the affairs of society—attitudes which are tending to divide the world into opposing camps—leads to a challenge to develop a responsible citizenship in line with the democratic tradition of Great Britain and of Western civilization, by constantly subjecting national organisation and power to the criticism and correction of ideas working in men's minds, and redeeming ideals and principles from ineffectiveness by supplying power and organisation to realize and uphold them. Stressing the grave dangers which attend the decay of the belief in progress, the Commission emphasizes the necessity for a moral and religious motive which, in Prof. A. N. Whitehead's words, "can render clear to popular understanding some eternal greatness incarnate in the passage of temporal fact".

Discussing next the conceptions of popular sovereignty and the supremacy of law, and the synthesis of power and law in the British national tradition, the Commission maintains that the coming of atomic power makes it more than ever necessary to preserve the conditions in which human lives can grow, and in a passage reminiscent of Lord Lindsay's discussion of the functions of the churches and the universities in his "Religion, Science and Society in the Modern World", suggests that our immediate task is to encourage everywhere groups which are learning to practise democratic fellowship and are thereby becoming the nuclei of a new social consciousness. Further, since ideas become effective by being embodied in institutions, it is a vital task in the present crisis to preserve and foster tradition, where it still survives, while at the same time fearlessly adapting it and expanding it to meet the demands of a changing society.

The achievement of democracy has been to curb and discipline power, not to abolish it; but although the Commission regards the realization of an effective world community as the most urgent task of our time and the only ideal which now offers reasonable hope of eliminating from human society the danger of atomic war, it does not suggest that such a world community is inevitable or easy to achieve. The obstacles are concisely indicated, and particularly the clash of irreconcilable ways of life which dominates the relations between the Anglo-Saxon world and that of the U.S.S.R. That dilemma is put as clearly as it is by Mr. J. Middleton Murry in his pamphlet "Trust or Perish"; but the Commission of the British Council of Churches does not conclude with him that Great Britain should declare that in no circumstances would we participate in another world war, and that this declaration should be made irrespective of the attempt to put the atomic bomb under international control. On the contrary, it is clear that the Commission is divided on the issue. Some at least of its members regard the problem as the provision of effective means of police action to restrain a lawless and anti-social member of the community of nations from seeking to attain its ends by violence, and that to assume that the best means of saving humanity from atomic warfare is to renounce in advance the right of defence might well prove to be a serious political miscalculation.

The Commission does not believe that Christianity is able with its present insight to pronounce between the two alternatives, but it urges that the intolerable nature of the dilemma by which we would be confronted by an outbreak of atomic warfare is an overwhelming reason for doing all in our power to further the proposal to eliminate from the armaments of all nations weapons adaptable to mass destruction. In the following chapter it admits that the Churches must recognize more fully than they have yet done that, in regard to a host of problems of conduct in our complex society, they do not know the right answer, and that that answer will be found only through the combination of ethical insight with the support of disciplined empirical research. Equally, however, it holds that the world which is apprehended by the methods of science is not the whole of reality, and the real danger to a scientific society is in the increasing opportunities which scientific advance presents to men's power-seeking impulse, and the inevitable extension of the field of organisation in which men are less and less related to one another as responsible persons and become interchangeable units in a vast machinery of production.

The Commission in fact has put the problem in much the same way as J. T. MacCurdy in "The Structure of Morale"; but it has not remarked, as he does, that what is needed is a new type of organisation, comparable in efficiency with that of the human body. Yet when it reaches the conclusion that the only adequate response to the challenge of the crisis resulting from the discovery of atomic power is that mankind should recover a new wholeness of living, it is not far from the position which Dr. MacCurdy

reached earlier from a wider point of view. Nor indeed does it differ widely from Dr. Wimperis' ultimate diagnosis of a great moral challenge facing us, the kind of challenge implicit always when we achieve new powers which can be turned to good or ill account.

To believe in the reform of human society may indeed be an act of faith, but to believe in it without a change of heart, it has truly been said, is an act of lunacy. Here on this ultimate moral plane we find little guidance as to how mankind may come to that humility of soul, the cleansing of hearts from pride, vainglory, hypocrisy and unworthy material ambitions which, Dr. Wimperis reminds us, may be part of the price that must be paid. One thing is certain: mankind must, in Mr. Murry's words, trust or perish; and one essential step to that trust must be the elimination as fully and swiftly as possible of all national claims to secrecy.

The rally of scientific opinion in favour of the free interchange of scientific information is duly acknowledged in the report of the Commission of the British Council of Churches as an event of outstanding importance. It has been made abundantly clear that free communication is the life-blood of science, and when the Atomic Scientists' Association in its memorandum urges that, as the scheme for international control of atomic energy becomes effective, the existing secrecy rules should be lifted and that eventually all research and development should be carried on freely and openly, with a duty to report to the United Nations Organisation any significant results, it is promoting not merely the interests of science itself but also that wider understanding out of which mutual confidence grows.

Powerful and unmistakable as is this support for freedom of communication—the statement also urges that the free movement and interchange of all men of science, including those working on atomic energy, be permitted and encouraged to the fullest extent—it is not support for indiscriminate or precipitate disclosure. That has been made plain alike in the American report on the International Control of Atomic Energy and in the British declaration, and also in Dr. Wimperis' little book; and nothing could be more unfortunate than any action by a responsible body of scientific men which suggested that it in any way condoned such disclosure or the violation of contract clauses. Apart from those technical questions with which the American report is concerned and to which the Atomic Scientists' Association has now given its support, there is no better way in which men of science generally can help forward the development of any scheme of effective control than by exerting themselves with the utmost determination and persistence to preserve both the integrity of science and the fullest possible freedom of communication, and to see that restrictions and secrecy regulations are relaxed or modified in response to reasoned agreement and as part of a considered plan. In that way, through exercising their own power with responsibility, men of science may make also some contribution, however slight, to the resolution of that moral dilemma which confronts both the continuance of civilization and the advancement of science.

ANTS AND MAN

Of Ants and Men

By Dr. Caryl P. Haskins. Pp. vii + 244 + 15 plates. (London: George Allen and Unwin, Ltd., 1946.) 12*s.* 6*d.* net.

THE behaviour of ants has excited the interest and the philosophical reflexions of man through the centuries. The parallels to be drawn between the social lives of these insects and those of the human race have only occupied attention in recent years. As the author of this book remarks, the question that comes into prominence is how far can we compare these ant societies with our own without becoming hopelessly involved in a bog of anthropomorphism? In other words, he goes on to reflect, can we legitimately "go to the ant" without reading into our findings many things that really do not exist? The consideration of these and kindred subjects and their elucidation form the main reasons for writing this book. As the author goes on to say, among the very few living creatures whose social development at all parallels our own, the ants are predominant. Their social system, however, is of far greater antiquity than that of man, perhaps by fifty, or more, million years. Ages before man had become evolved ants were already so much like their descendants that many of their fossil representatives have been relegated to living genera. Ants have the further advantage in that they have been able to depend upon a host of genera and species for the furtherance of their evolutionary trends, whereas the society of man has had, at most, scarcely a handful of species available. The inevitable consequence has been the survival to the present day of a nearly complete series of evolutionary forms among living ants—numerous 'missing links' and 'living fossils' are thus available for study. The evolutionary history of ants, therefore, is much more complete and much better preserved than that of man.

The dawn of ant evolution is considered by the author, in company with other authorities, to be traceable back to some of the primitive saw-flies that are only known to us as Jurassic fossils. From analogy with living saw-flies, it is concluded that these forerunners laid their eggs in incisions made in the tissues of living plants. It is but a relatively short step from such a habit for the female insect to deposit her eggs on the bodies of living animals instead of plants, and for the resulting larvæ to burrow into their vitals, instead of among cell walls and sap. So it would seem the parasitic Hymenoptera came into being. It was from such parasites that the bees, wasps and ants—the Aculeata as they are conveniently termed—are believed to have been evolved. From the ichneumon flies evolution may have gone on through the Scoliid wasps and finally to the Ponerinæ, which are the *stirps* of the ants.

Dr. Haskins gives a very readable and adequate background of some of the main features of ant societies and comments on the parallels to be found in some of them to features of the lives of mankind. He turns, where desirable, to a more detailed survey of certain special aspects of ant societies and gives careful consideration of the light they may shed on certain sides of human society. He deals in particular with certain phases of the social life of ants, and has little to say about their lives as individuals or of the physiological or psychological problems they present. This restriction is explained by the title of the book, since it is those phases of ant society

which show the closest correspondence with human society that receive the bulk of his attention.

While it may seem far-fetched to distinguish totalitarian from democratic social structures in ants, yet, as Dr. Haskins says, a close scrutiny can reveal the most surprising superficial likenesses in the general social trends of ants and humanity. Below the surface there may be a deeper and more fundamental significance than is yet realized. The author attempts to point out some of these analogies with the object of helping to throw light upon the structure of human society itself. Here we must close this notice of an able and thoughtful book, written by a naturalist and scholar well versed in his subject.

A. D. IMMS

BRITISH TREES AND GARDEN FLOWERS

British Garden Flowers

By George M. Taylor. (Britain in Pictures Series.) Pp. 48 + 8 plates. (London: Wm. Collins, Sons and Co. Ltd., 1946.) 4*s*. 6*d*. net.

Trees in Britain

By Alexander L. Howard. (Britain in Pictures Series.) Pp. 48 + 8 plates. (London: Wm. Collins, Sons and Co. Ltd., 1946.) 4*s*. 6*d*. net.

THE two latest additions to Collins' "Britain in Pictures" series fit into a natural history section which has achieved a satisfactory standard. "British Garden Flowers" is a good companion to the already published "Wild Flowers in Britain", and "Trees in Britain", since it deals with native and exotic types, forms a useful supplement to both.

The book on garden flowers has been written by a horticulturist of great practical skill and experience who has himself done much to perpetuate many of our well-established cultivated types which have been in danger of extinction in Britain. Mr. Taylor writes with rare enthusiasm, born of the love of his subjects, which imperceptibly communicates itself to the reader whether in dealing with such typically English flowers as the rose—which originally hails from China—or with fairly recent importations like the German iris which the British gardener has so unwittingly stripped of its Teutonic character.

Besides his charming accounts of extant British cultivated flowers, Mr. Taylor, perhaps unconsciously, has also indicated the natural approach to history. There is, for example, the story of how gardening apprentices in the seventeenth century spent their evenings in the bothies after the day's work, being grounded in Latin by the old gardeners. Nor, in tracing the introduction of various foreign plants to Great Britain over the last five centuries, is it possible to avoid tracing the evolution of Britain as the centre-piece of the British Commonwealth of Nations.

This historical background should prove a useful corrective to those who believe that the rich, variegated, multi-coloured floral specimens of to-day (like the tulip, for example) are fairly recent in origin; it should be an encouragement for the more 'old-fashioned' people who believe that modern horticulturists go too far in replacing 'traditional' British garden flowers with new varieties of a somewhat bizarre and foreign appearance.

It is also interesting to note that Mr. Taylor does not allow his love of garden flowers and of their origins to obscure his belief that new British varieties of the future may come more from the geneticist and plant cytologist than from the explorer.

The text of "Trees in Britain" is not quite as impressive as Mr. Taylor's book, mainly because Mr. Howard has chosen a more formal style of describing his trees in regular order and with fairly set patterns of description for each. His idiosyncrasy of using generic names with small initial letters is also disturbing, as are the odd mistakes in spelling and wrong naming of trees. Thus *Robinea pseudacacia* is throughout called the 'acacia', although Mr. Howard explains that the tree is known to the botanist as the false acacia. The specific naming of elms is also not in accordance with the generally accepted botanical view; which can only lead to confusion. The correct nomenclature for the elm flora in Britain was given by Dr. R. Melville in *Nature* of February 12, 1944, p. 198. The author, too, in advocating the need for extensive re-afforestation schemes for hard woods, would have made a better case without first stating that plantations of Scots pine, larch and spruce add little to the beauty or amenities of the country, and later, when considering individual species, describing them by the way they "strike and delight the eye in the distance or in the horizon". There are, in the book, several black and white illustrations and coloured plates. Each is by an artist of repute and themselves alone make the book fitted to take its place—together with the equally well-illustrated "British Garden Flowers"—with credit in a generally admirable series.

T. H. HAWKINS

THE HUMANITIES AT LARGE

A State University Surveys the Humanities

Edited with a Foreword by Prof. Loren C. MacKinney, Prof. Nicholson B. Adams and Assoc. Prof. Harry K. Russell. (University of North Carolina Sesquicentennial Publications.) Pp. xi + 262. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1945.) 24*s*. net.

THE writers of this book, which emanates from the Division of the Humanities of the University of North Carolina, conceive of the humanities not so much as subjects of study as ideals of study, believing that every course in a university can appropriately embody the humanistic spirit.

The publications to which the book belongs are described as sesquicentennial—a fearsome word, the exact origin of which is the subject of learned guesses. It merely means that the University of North Carolina completed a hundred and fifty years of its existence in 1945. In the late eighteenth century the young republic had no more desire for popular education than had the old country. In the creation of State universities, however, it was progressive, and the South took the lead. The States were too poor to provide money; but they had unoccupied lands at their disposal. North Carolina chartered a State university in 1789, but provided no money, buildings or equipment. "Not until 1795 did the university begin work at Chapel Hill, and then it had to depend for support largely on private gifts, the sale of lands, and students' fees. It was in time to become one of the most influential universities of America, but a long rough road lay ahead of it when the nineteenth century opened."[1]

This volume is one of seventeen sesquicentennial publications; but this one alone is sufficient to prove

the fine achievement that began in that rough road. Taken as a whole, these essays are written with a masterly grasp of the subjects treated, and with a vigour of expression worthy of what is, after all, a youthful institution, notwithstanding its sesquicentennial status. The general conception that every course in a university can embody the humanistic spirit is seen in the range of contributors. For the participants include not only spokesmen for the ancient and modern languages and literatures, the fine arts, history and philosophy, but also for social studies, the sciences, mathematics, medicine, commerce, journalism and law. An introductory essay traces the history of humanistic studies in the university; eleven essays discuss the humanities and the humanistic ideals in university education to-day; four present the views of professional men; and a concluding essay envisages the State university of the future as one the entire programme of which is guided by the spirit of the humanities.

Readers of *Nature* will be specially interested in the essays on the sciences, so we turn at once to the chapter entitled "The Biological Sciences: the Sciences in the Humanities". This is indeed a rousing chapter. The writer abandons the long-prevalent distinction between the sciences and the humanities. It is his strong conviction (and he speaks as a professor of zoology) that sciences take high rank *among* the humanities. He denies the current statement that science is concerned with facts, and the humanities with values. Are we not, then, he indignantly asks, to count among the values, understanding of the world in which we live and appreciation of the beauty of growing generalizations concerning protoplasm, electrons and star galaxies? Are we not to recognize among the values the development of the imagination or the freedom of the mind and spirit? We are left with the dilemma that either the natural sciences are among the humanities, or a leading part in the liberation of mind and spirit is left to non-humanistic disciplines.

Turn now to mathematics and the physical sciences. The essayist quotes John Dewey, a philosopher "with a deep insight into mathematics and the process of scientific thinking". In the process of discovery of truth, says Dewey, the mathematician and man of science experience an æsthetic satisfaction which, if more intellectual and austere, is comparable to that experienced by the artist in disclosing beauty in Nature or in the human form. To the same purpose, he continues, Bertrand Russell, both mathematician and philosopher, says that mathematics, rightly viewed, possesses not only truth but also supreme beauty—a beauty cold and austere, like that of sculpture, and capable of a stern perfection which only the greatest art can show. The writer of the essay adds that the historians who have extolled "the glory that was Greece" seemed to be unaware that the Greeks were men of science—"a discovery which thinkers as far apart as Arnold and Huxley announced, perhaps without knowing quite why".

With the remaining essays we must deal more cursorily than they deserve. The professor of sociology holds that the social sciences have a great opportunity of bridging the distance between the exclusive humanities of former times, and the realities of human society trying hard to recapture the elemental balance between the individual and the group. The essay on history directs attention to the fact that "the pure sciences are increasingly busied with their own histories, which can but mean an accentuation of those elements of human sacrifice, devotion, and genius upon which the sciences have fed and flourished". The first of two noble chapters on literature collects an array of literary evidence to show that among animals man is unique in organising the mass murder of his own species, and the second (one of the best in the whole series) bids the student to go straight to the great books, the truly scientific method, and not to approach them by the falsely scientific method of footnotes, compendia, influences, types and movements.

As one lays down this "survey of the humanities" one understands why the university at Chapel Hill stands high in American reputation, and one realizes that the spirit which animates the survey is needed in Britain too, where, for example, the possessor of a university degree is often too narrowly equipped to be regarded as a well-educated man.

T. RAYMONT

[1] Beard, C., and Beard, M., "The Making of American Civilisation", p. 267.

THE CAVENDISH LABORATORY

The Cavendish Laboratory

By Dr. Alexander Wood. Pp. 59 + 8 plates. (Cambridge: At the University Press, 1946.) 2*s.* 6*d.* net.

TO attempt to write the history of any virile institution, covering three-quarters of a century, in some 13,000 words is to accept very grave limitations in respect of mode of presentation and depth of treatment: when the institution in question happens to be the Cavendish Laboratory there is the added difficulty that the whole subject is one with which the general reader is sadly unfamiliar. For it must be supposed that the slim volume under review is addressed to the general reader. Yet the intelligent non-specialist will derive some solid benefit from pondering Dr. Wood's pleasant but essentially sober account. He may not sense the rare atmosphere of the place, which has been the inspiration of so much that has been important for the advancement of knowledge over the last fifty years, nor catch the excitement of discovery which so often has flared to fever-heat within the once drab walls; but he will have a record of development from which certain facts emerge which repay consideration.

He will find how much this institution, of world-wide repute, owes to the generosity of private benefactors—the seventh Duke of Devonshire, Lord Rayleigh (third Baron), Dr. Ludwig Mond (through the Royal Society) and Lord Austin, to mention only those commemorated by name in its buildings. He will be able to follow the growth in numbers of undergraduate and research students, and to appreciate something of the general increase in scale of research equipment during the last quarter of a century. He will realize then the change that has come over the duties of the Cavendish professor since Maxwell was appointed in 1871 "to teach and illustrate the laws of Heat, Electricity and Magnetism; to apply himself to the advancement of knowledge of such subjects; and to promote their study in the University". When he has appreciated this he may cease to wonder that, though Maxwell was appointed to the chair at the age of thirty-nine, Rayleigh at thirty-seven and Thomson at twenty-eight, their successors have been men of more mature years.

N. FEATHER

TROPICAL MEDICINE IN THE BRITISH EMPIRE

SUGGESTIONS FOR THE FUTURE

By Sir PHILIP MANSON-BAHR, C.M.G.

IN an article in *Nature* of March 16 an attempt was made to outline the present position of this important branch of medicine and research, especially as regards teaching in London. There is general agreement that the identity of the School of Tropical Medicine created by Manson's genius should be preserved and its activities and usefulness in the tropical sphere expanded. No longer can there be any question of a survival, but rather of a bid for supremacy in a field of science which has become the nation's birthright. Recently it has become abundantly clear that, if some practical steps are not taken to maintain our lead in tropical medicine, it may soon be overtaken by the United States, where eager and virile minds are contemplating this subject, stimulated or even enriched by hard-won experiences and researches in many tropical lands during the agonies of a world war. Collaboration, not competition, should now be the watchword in formulating plans for the future.

The prime difficulty of provision of adequate facilities for sufferers from tropical diseases contracted during military service, as the result of exposure to untold hardships in prisoner-of-war or civilian internments camps, has been countered. During the autumn of 1945 the position appeared to be singularly unpropitious, and voices were heard sounding notes of alarm. What accommodation had been provided for the thousands who would shortly be cast upon us riddled with all forms of tropical disease? These fears proved to be to some extent unfounded, for, such are the miraculous recuperative powers of the human frame that, within three months of the internees' release, the vast majority had been restored to pristine health. The stigmata of pellagra, hunger œdema and beriberi had been removed by a generous, nourishing diet and vitamins. Many have actually doubled their starvation weight. Sound flesh and muscle once more clothed the protruding bones and a ruddy countenance had replaced the sallow sunken cheeks. Only a small minority were found to be suffering from residual infections with malaria, amœbic dysentery and worm infestations originally contracted in the Far East. One of the graver diseases, sprue, which so commonly affects Europeans in these regions and which has played so notable a part among soldiers and airmen in India and Burma, has been conspicuous by its absence among these internees. The reason for this singular exception is by no means clear.

Although the difficulties of the present economic situation have been considerable, the Board of the Seamen's Hospital Society has now provided accommodation for sufferers from tropical diseases in the new Hospital for Tropical Diseases in Devonshire Street, London, in addition to wards in the Albert Dock Hospital. The official statement of a long-term policy for a well-equipped institution in the university quarter of London has done much to allay anxiety for the future. Therefore there no longer exists any genuine justification for the statement that provision for tropical patients is lacking in London. As regards clinical teaching the position has also improved in a manner that was scarcely thought possible. Necessity still remains the mother of improvisation, and a solution of our difficulties has been found in wholehearted and widespread collaboration.

As there exists at present an abundance of tropical patients, scattered in many directions, a scheme for clinical instruction has been evolved which embraces several institutions including the Ministry of Pensions Hospital and the hospitals of the Seamen's Hospital Society, while by permission of the military authorities clinical demonstrations have also been given at Millbank Hospital, London. This privilege, which marks a new departure, has been particularly appreciated. There are undoubtedly solid advantages in the plan outlined above—advantages which are mutual—and it is clear that this system of collaboration in clinical instruction is one which can be profitably pursued so as to provide an abundance of clinical material for teaching and research which should suffice for several years to come. One practical and much-appreciated outcome of this arrangement is that it secures a wide selection of cases, while the students receive instruction from a panel of clinical teachers with varied and independent points of view.

In order to provide opportunities for recondite research, which can best be carried out in a great medical centre such as London, there can never be a plethora of patients, so all available channels must be drained in order to maintain a constant and adequate supply, especially from the dock area of London. It is to be hoped that whenever the ultimate scheme for an organised central institution comes to full fruition, this important axiom may not be overlooked.

The close association of chemotherapeutic laboratories with tropical medicine is a necessary corollary. Such fundamental therapeutic advances as are being made can be only further developed if this liaison is maintained. We have already witnessed the success which has attended this particular kind of co-operation in the discovery and exploitation of antimalarial drugs in Germany, where the I.G. Laboratories at Elberfeld were linked with the staff of the Tropical School in Hamburg. The preliminary trials on human malaria patients were carried out in the wards of the Tropical Hospital and thereafter field trials were conducted on an extended scale in various tropical centres. This same method has been practised during the past year by Imperial Chemical Industries in Manchester, where the newly discovered drug for malaria, 'Paludrine', has been synthesized by a brilliant team of chemists. After a series of exhaustive laboratory tests on chickens infected with *Plasmodium gallinaceum*, its adaptation to man was explored on malarial patients in the hospitals attached to the Liverpool School of Tropical Medicine. The knowledge obtained by these preliminary tests is now being amplified by field trials. Therefore, it is self-evident that the closer and more intimate the connexion, both in an academic and geographical sense, between the clinical division of a tropical school and chemotherapeutic laboratories, the more successful will be the outcome of this collaboration.

There are several tropical diseases, in addition to malaria, for which a search for specific remedies is desirable. A striking example is amœbiasis. As is well known, some of the amœbic infections contracted during war service in the Middle and Far East have shown themselves particularly resistant to the well-established remedies, such as emetine and its compounds; but now that it has been found

possible to reproduce this disease in rats, it is confidently hoped that still more efficient remedies may soon be discovered.

Then there are other parasitic diseases, as for example bilharziasis, trypanosomiasis and leishmaniasis, all of which can be maintained in laboratory animals, in the treatment of which, though we already possess powerful specific drugs, further improvements may be reasonably expected. For filariasis, which is so widespread in the tropics, we possess at present no efficient antidote. The more important species of filaria (*Wuchereria bancrofti*) produces particularly loathsome, crippling effects, while the West African parasite (*Loa loa*) also leads to disagreeable disabilities. It is particularly dangerous to experiment with powerful drugs on human filarial patients for obvious reasons, so that it is necessary to have recourse to analogous or closely related parasites in animals. Fortunately such a filarial infection has been found in the cotton rat (*Sigmodon hispidus*). This is a rodent suitable for laboratory purposes. Its filarial parasite, *Litmosoides carinii*, can be utilized in tests with various antimonial preparations. This development has brought discovery of a remedy for human filariasis within the bounds of possibility.

Contemplation of this line of thought brings us to a jejune subject to which the attention of tropical workers is invited. By this is indicated the desirability of creating some central institution, or depot, for the maintenance of strains of tropical parasites and their intermediary hosts to provide material for vital work of this nature. Such a centre could be envisaged as a miniature zoological garden situated in some rural district on the outskirts of London and within easy reach of the main central research institutions. It should be equipped with the necessary hot-houses, animal houses, stables and laboratories where these lowly creatures can be tended and propagated in order to supply specimens both for teaching and research. It should be comparatively simple to design tanks and aquaria for the breeding of various freshwater molluscs which serve as hosts for pathogenic trematodes, especially those of the bilharzia group, and in these modern days of organised aerial transport it should not be a difficult matter to secure the regular dispatch of freshwater molluscs from Egypt and the Middle East to such a depot. If this could be organised on a sufficiently large scale, students of the tropical schools could then be afforded more efficient and practical instruction than can be obtained from diagrams or text-book illustrations, while abundant opportunities would be provided for testing out chemical compounds suitable for the eradication of bilharziasis in Egypt and other countries where this disease constitutes a constant menace to the inhabitants. From the Far East it should also be possible to procure snails of the genus *Oncomelania*, the intermediary of *Bilharzia japonica*, a parasite which causes untold misery in China and adjacent countries. This species of bilharzia is particularly suitable for laboratory purposes as it commonly infests domestic animals and can be maintained in cats and dogs.

Other trematodes of medical importance are also found in wild and domestic animals in Nature. Such are *Clonorchis sinensis*, the Chinese fluke, and *Paragonimus*, the long fluke, both of which could be propagated in such a depot.

There is also no valid reason why cestodes, especially the *Diphyllobothriidæ*, which afford such a valuable demonstration of helminthic evolution, should not also be considered in such a scheme.

Among nematodes, the guinea-worm, *Dracunculus*, in addition to man, also parasitizes dogs, monkeys and raccoons. It undergoes a most interesting development in the water-flea, *Cyclops*, a crustacean which can be reared in the laboratory. This is an important parasite, as the present methods of prevention and of cure of this infection are not by any means satisfactory.

The list of suitable pathogens, of which a mere outline has been given, could be greatly expanded if the imagination is permitted to run riot on this theme. The breeding and maintenance of the many tropical insects—mosquitoes, midges and flies—is a highly technical subject and necessitates the construction of elaborate insectaria which require constant care and attention. Most institutions vitally interested in this speciality find this a heavy, and some an intolerable, burden. They would welcome the organisation of a specialized centre whence stocks could be replenished and new strains secured from time to time. Should such a depot for living parasites and their hosts prove acceptable to teachers and research workers in Great Britain, a start would have to be made on a modest scale and progress secured by practical experience.

In order to explore the ground it would undoubtedly be desirable for one or more enthusiasts to visit medical centres in Africa and the Far East with the object of organising a chain of collaborators able and willing to collect and dispatch consignments from time to time. For this purpose it would be necessary to construct tanks and containers for the transport of these various creatures, and a good deal is already known about the methods which should best be employed.

In this short article the possibilities of such a scheme can be merely outlined and it would depend upon the measure of support such a proposition gains before details could be more minutely considered.

Another manifest defect in our system of teaching at the present time is to be found in the scarcity of pathological specimens of tropical interest for demonstration and museum purposes. The pathological exhibits of the London School of Hygiene and Tropical Medicine and the series collected during the First World War at the Royal College of Surgeons have been destroyed by enemy action. Although the fine tropical section of the Wellcome Museum is now being reorganised, it is evident that many specimens are missing, while many others should be replaced. Here is another avenue to which our energies could well be directed. Past experience has shown that it is necessary for the preparation and preservation of pathological specimens for museum purposes that intimate personal contact must be secured with pathologist and laboratory workers in the tropics.

The pathological laboratories and mortuaries of the great tropical centres, such as Colombo, Rangoon, Singapore, Shanghai and Hong Kong, are replete with such material, a great deal of it of outstanding pathological interest, which from lack of suitable containers, trained staff and preserving fluids has to be destroyed. It is eminently desirable, nay essential, for the tropical schools in Great Britain to collaborate in the dispatch of an expedition to visit many of these centres, provided with the necessary reagents and containers for preserving pathological specimens.

This theme is not the vapourings of a visionary, but the outcome of practical necessity. That overworked doctors in the tropics, encumbered by so many practical difficulties and shortcomings, should collect and preserve specimens destined for institutions with which they themselves are not directly connected is to expect too much. We must now be prepared to exert our personal endeavours to obtain what is so essential for the teaching of tropical medicine. The harvest is indeed plenteous, but the labourers are few in the present disorganised state of the world. This is especially true of those Eastern countries recently released from the stringencies of war. Their medical services are now being rapidly reorganised and progress is becoming apparent. It should therefore be possible to put some of the suggestions outlined in this article into operation within the near future.

RADIO METEOROLOGY: INFLUENCE OF THE ATMOSPHERE ON THE PROPAGATION OF ULTRA-SHORT RADIO WAVES

WITH the introduction of radio waves a few metres in wave-length in the years before the Second World War, and of centimetric waves during the War, entirely new meteorological effects on propagation have come to light. The first of these is the variable, non-rectilinear propagation of metric and centimetric waves through the lower atmosphere, the range of such waves over the earth's surface often far exceeding the geometrical horizon of the transmitter. Ionospheric reflexion plays no part in this propagation, for in the wave-lengths concerned penetration of the ionosphere is almost or quite complete. The second major phenomenon is the strong reflexion and attenuation of the shorter of these waves by suspended water drops or snow crystals when present in sufficient density in or beneath a cloud. Much of the knowledge acquired on these phenomena during the War was described and discussed at a joint conference of the Royal Meteorological Society and the Physical Society held at the Royal Institution on April 8.

An introductory survey of the radio-meteorological field was made by Sir Edward Appleton. He recounted the history of the experimental and theoretical work from the pre-war results of England, Crawford and Mumford using 4 m. and 2 m. waves in the United States over land and sea to the later war-time results of the Services on centimetric radar sets. With cloudy weather and strong winds the range of a radio or radar transmitter over the earth's surface is a little more than the distance of the geometrical horizon of the transmitter aerial; but in certain other types of weather the range may be many times this value and occasionally it may be slightly less, the effect of the weather being in general greater the shorter the wave-length. Thus in July 1941, a 10 cm. radar set on the south coast of England was 'seeing' 170 miles across the Channel for several days on end in warm, settled weather, though the geometrical horizon was less than 40 miles. More striking is the performance of a 1·5-m. radar set near Bombay at a height of 80 m. above sea-level; during the monsoon season it was able to plot ships up to the expected range of 20 miles; during the hot season, however, it commonly reached shipping at 200 miles, once attained 700 miles, and not infrequently saw the coast of Arabia at 1,000–1,500 miles. Note that both examples refer to propagation over the sea, where the meteorological effects tend to be most pronounced. How are such observations, by no means unusual, to be correlated quantitatively with the meteorological conditions?

If the atmosphere were absent the propagation of radio waves would be rectilinear and, small effects of diffraction apart, no signal would be received beneath the geometrical horizon of the transmitter. The atmosphere being present, a ray inclined to the vertical will be bent downwards if the refractive index of the air decreases with height, and conversely, downward bending producing an increased range and upward bending a shorter range along the curved surface of the earth. Such upward and downward bending has long been known for light rays, producing the so-called inferior and superior mirage respectively. But optical mirage is usually rather slight whereas radio mirage, particularly of the superior type, is quite common and, as the above examples show, large in amount as measured in range. The reason for the difference is the much greater refracting power of water vapour for radio waves than for light waves. The change in φ, the inclination of a ray to the earth's surface, with distance s along the surface is given by

$$\frac{d\varphi}{ds} = \frac{1}{R} + \frac{1}{\mu}\frac{d\mu}{dh},$$

where h is the height of the ray above ground, R the earth's radius and μ the refractive index of the air. Since μ is almost unity, this may be written

$$\frac{d\varphi}{ds} = \frac{1}{R} - \alpha,$$

where $\alpha = -d\mu/dh$ is the lapse-rate of refractive index. Now in the study of ray paths, it is convenient to regard the earth as flat, and the quantity $d\varphi/ds$ is then the curvature of the ray relative to the earth's surface. In the absence of an atmosphere ($\alpha = 0$) the relative curvature is $1/R$, and with the atmosphere present $1/R - \alpha$ ($= 1/R'$ say). The vertical gradient of refractive index is usually negative (α positive) so that R', the effective radius of the earth, is usually greater than R. If α reaches the critical value of $0{\cdot}15 \times 10^{-6}$ per metre, R' becomes infinite and the earth effectively flat, while for greater values of α than this R' becomes negative, the earth effectively concave, and radio vision around the curvature of the earth becomes possible. In a well-mixed atmosphere α is positive but less than the critical value, with R' equal to about $\frac{1}{4}R$. Such a value of R' implies a measure of downward bending, while a condition of super-refraction is said to exist if R' is greater than $\frac{1}{4}R$.

The gradient of refractive index is determined by the gradient of density of dry air (in terms of observables, of pressure and temperature) and of the associated water vapour. Pressure decreases with height at an almost constant rate near the earth's surface and contributes therefore a more or less constant positive amount to the lapse of density and therefore to α, namely, $0{\cdot}03 \times 10^{-6}$ m.$^{-1}$. If now the temperature decreases with height (lapse of temperature) the air density and therefore the refractive index fall off with height less rapidly than in an isothermal atmosphere, whereas if the temperature increases with height (inversion of temperature) the lapse of density and of refractive index is enhanced above isothermal

values, a gradient of ± 1° C./10 m. contributing about $\pm 0{\cdot}16 \times 10^{-6}$ m.$^{-1}$ to α. An inversion of 1° C./10 m. provides, therefore, rather more than the critical value of α for the earth to be treated as flat. Finally, a lapse of vapour pressure makes a positive contribution to α, and conversely, ± 1 mb./30 m. producing $\mp 0{\cdot}13 \times 10^{-6}$ m.$^{-1}$ in α. Thus an inversion of temperature associated with a lapse of vapour pressure is the most favourable combination for a super-refracting atmosphere.

Prof. P. A. Sheppard discussed the physical processes determining the vertical gradients of temperature and humidity in the bottom kilometre of the atmosphere and assembled observational data on their magnitudes. One or more of the following factors, (*a*) the net radiation inflow (positive or negative) at, and the physical properties of, the earth's surface, (*b*) the horizontal gradient, in the direction of the wind, of temperature and vapour pressure at the earth's surface, (*c*) the rate and pattern of subsidence in the free atmosphere, combine with the intensity of the mixing process in the vertical to determine the magnitude of the gradients concerned. When neither of the factors (*a*), (*b*) and (*c*) is large in the meteorological sense, the lapse-rate of temperature near the surface in a well-mixed atmosphere is very near the so-called dry adiabatic value of 1° C./100 m., a value too small to produce any material control on the curvature of radio rays, and the gradient of humidity will also be negligible so far as its effect on α is concerned. Under strong insolation, the lapse-rate of temperature over the land may amount to 1° or 2° C. per 10 m. in the bottom 20 m., decreasing with increase in height up to about 100 m., while on a clear night with light wind the net outflow of infra-red radiation from the surface may produce an inversion of temperature about twice as great numerically as the day-time lapse and extending to an increasing height with time during the night up to about 300 m. Thus, so far as the temperature is concerned, sunny days on land are inimical to super-refraction, while calm, clear nights are favourable. Over the open sea such diurnal effects are absent, because of the much higher effective thermometric conductivity of water than of land. The gradient of vapour pressure over the land follows much the same diurnal course as the gradient of temperature provided the surface is not dry or the vegetation withered, the boundary value of vapour pressure following approximately the change in surface temperature along the saturation vapour-pressure curve, There is, however, generally a lag of an hour or two in the onset of an inversion of humidity on a clear evening behind the onset of the temperature inversion. The observed day-time lapse of vapour pressure may amount to 1 or 2 mb. per 10 m. over the lower 10–20 m. during very hot weather, and the night inversion to rather smaller numerical values, both decreasing numerically with height. Thus the diurnal effect of humidity gradient on refractive index is comparable with, and opposed to, that of temperature gradient except in the early evening. Again, diurnal effects on vapour pressure are absent over the sea.

Passing from diurnal effects, when a light or moderate wind blows over a surface the temperature of which changes, either abruptly or continuously, in the direction of the wind, appreciable departures from the adiabatic lapse of temperature may be produced in the lowest few hundred metres, and humidity gradients corresponding to the air mass and surface humidities will also arise. This so-called advection condition is most marked in the lower atmosphere when the surface temperature falls in the direction of the wind, for the vertical stability associated with the inversion of temperature then formed confines the effect of the changing boundary condition to a relatively shallow layer of air. Further, if in this case the air mass is initially very dry and moves over the sea, the evaporation at the surface will produce an appreciable lapse of vapour pressure in the lower atmosphere, so that temperature and humidity profiles combine towards super-refraction. Such a condition arises when anticyclonic air moves out from a continent over the sea in summer, and is responsible for a majority of the long radar ranges observed over the sea.

The air in an anticyclone and certain other situations subsides from aloft and spreads out horizontally at low levels, the adiabatic heating of the air during descent generally resulting in an inversion of temperature at the base of the subsiding layer to be found between 0·5 km. and about 2 km. height. Such subsiding air, having moved from levels of low temperature, is also generally very dry, whereas the air beneath the subsiding column is likely to be damp due to surface evaporation. Thus the inversion of temperature is likely to be associated with a strong lapse of vapour pressure. Only recently has the fine structure of such subsidence inversions been observed, gradients of as much as + 3° C. in 7 m. or 6° C. in about 30 m., and in vapour pressure of −2 mb. in 7 m. or −3·5 mb. in 30 m., having been found over Britain. Again a super-refracting atmosphere results, though how important such raised inversions are likely to be in radio propagation has yet to be determined completely.

Dr. R. L. Smith-Rose presented data on the effect of weather conditions upon the propagation of 9-cm. and 3-cm. waves over the land and over the sea which, in part at least, fit well with the above considerations. In the sea trials, meteorological soundings of pressure, temperature and humidity were made so as to provide values of the refractive index up to about 500 m. over the radio links, and encouraging correlations were found with field strength at the receivers. Exceptionally high accuracy is required in the meteorological observations in order to provide trustworthy profiles of refractive index, so that some scatter in the correlation was not surprising. This apart, there were indications that a simple refraction theory was adequate to explain the observed fields except for low-level links, for which the field strength was systematically greater than simple theory would suggest.

Surface observations only of weather were available on the land-link trials, in which high signal strengths were frequently observed at the receivers on clear nights and, perhaps surprisingly, during the advection fogs of autumn and winter ; whereas almost complete fade-outs occurred during radiation fog at night. The passage of a cold front across the link generally produced markedly variable signals, a feature also in evidence in the absence of any marked weather phenomenon and probably to be accounted for by the inhomogeneity of the atmosphere in temperature and vapour pressure.

The ray-tracing treatment in studies of propagation takes no account of the wave-length whereas this is an important factor, and Dr. H. G. Booker described to the conference a wave-treatment in which the principles of wave guides was extended to an atmo-

sphere with a given profile of refractive index. Certain observed forms of profile in the lower atmosphere provide a wave guide, or radio duct as it is called, either at the surface or in a slightly elevated layer, in which the energy of shorter waves is almost or completely trapped, and propagation around the curvature of the earth follows. But the leakage from such ducts increases with the wave-length, with the consequence that decametre and longer waves take no notice, as it were, of the fine-grained structure of the lower atmosphere. Prof. D. R. Hartree added to this branch of the subject by describing some ingenious mathematical devices which have been developed for tackling propagation studies for certain classes of profile.

In the discussion on the above aspects of radio propagation, Mr. F. Hoyle, to whom the concept of a radio duct is partly due, considered that, given the meteorological observations, field strengths could be calculated with satisfactory accuracy with more or less of labour, and that the important practical problem to-day is that the meteorologist should be able to forecast successfully the propagation conditions for some time ahead—no small problem in regions such as the temperate latitudes experiencing much 'weather' but little 'climate'. Mr. E. G. S. Megaw was not, however, quite so satisfied with present theory, and considered that the assumption so far made that the earth's surface is a perfect reflector and conductor needs re-examination.

The conference then passed to the absorption and scattering of radio waves in the atmosphere, on which subject Mr. J. W. Ryde gave the results of an intensive theoretical study which has received wide observational support. The attenuation and scattering of 2 cm. and longer waves is negligible for atmospheric gases but may be appreciable for suspended matter such as water drops, ice crystals and dust. For the small water droplets found in fogs and most non-precipitating clouds (diameter d of order 10μ) the attenuation and back scattering is proportional to d^3, and therefore to the total mass of liquid present irrespective of the drop-size distribution. The total mass of such water in a centimetric radar beam is, however, usually far too small to produce measurable echoes, though the attenuation in a kilometre of fog or cloud may be appreciable. For larger drops, for example, drizzle and rain, the Rayleigh law of scattering proportional to $(d/\lambda)^4$ applies, and considerable attenuation and echo intensity may result from clouds and the precipitation beneath them, particularly at the shorter wave-lengths. From the observed drop-size distribution for given rates of rainfall, Ryde deduces an attenuation up to 1 db. per km. on 3 cm. waves in Britain, and up to 6 db. per km. in the tropics where the heaviest rain occurs, the ratio of attenuation on 10 cm., 3 cm. and 1 cm. waves being roughly as 1 : 100 : 700. The echo intensity on 10 cm. radar from a cloud at 50 km. distance producing rain at the moderate rate of 7 mm./hr. is about the same as that for a small aircraft at the same distance, but on 3 cm. radar the echo intensity from the same cloud increases a hundred-fold. The increased sensitivity of the shorter wave-lengths is, however, offset by attenuation if precipitating cloud lies in the line of sight to the farther cloud. Precipitation usually begins as snow above the 0° C. isotherm, and Ryde has shown that, while a snow crystal is a less effective resonator than a raindrop of equal mass, the snow will produce an echo equal in intensity to that from the rain resulting from the snow, provided the snow crystals are not less than 1–2 mgm. in mass, a quite usual value, and will produce a much greater echo if the crystal aggregate is greater than about 5 mm. diameter. This results from the greater mass of water substance per unit volume of air in the snow region, the snowflakes having a lower terminal velocity of fall than the corresponding raindrops. Also arising from this interplay is the enhanced echo from a thin layer of cloud near the 0° C. isotherm, where the snowflakes melt and become better resonators but do not immediately reach their higher terminal velocities.

Lieut.-Commander F. L. Westwater followed with an account of the use to which radar echoes from storm clouds may be put by the synoptic meteorologist. As forecast by Ryde, the major echoes arise from instability showers, either scattered or such as occur along an active cold front, with or without thunder, the rate of precipitation in these cases being generally high. Such storms can be picked up sufficiently far off, and their path of travel and their development or decay followed so as to provide useful additional observations, particularly at sea or at a coastal station. Of special interest to aircraft and ships, and more generally, is the radar vision of tornadoes or other tropical storms and the plotting of their often variable tracks.

In discussion, Lieut. R. G. Ross referred to echoes occasionally obtained from unexpected meteorological quarters, for example, haze layers and strato-cumulus clouds, and when using metre-waves, so that much remains to be investigated before the significance of a particular echo will always be clear.

Mr. C. S. Durst read a paper on "Radio-Climatology", relating mainly to abnormal propagation. He has considered the likely general form of the temperature and humidity profiles in characteristic weather situations and areas of the world, and amalgamated them to provide tentative world charts of what may be called 'radio climate'. Such charts are at present more reliable for the oceans than for the land, since the meteorological phenomena are simpler over the oceans and less dependent therefore on long series of detailed observations not yet in existence or even begun.

Sir Nelson Johnson rounded off the conference by considering future developments in radio meteorology. In relation to abnormal propagation, many more observations are required of the humidity profile in order that an adequate theory of matter-exchange may be formulated and integrated with the theory of heat- and momentum-interchange in the vertical. Further, our knowledge of the subsidence mechanism in anticyclonic conditions and its relations with the temperature and humidity gradients at the subsidence inversion need elucidation for their own sake and in relation to radio-propagation. The problems associated with radar echoes from clouds are exceptionally important—and difficult. One is concerned with the vertical velocities in clouds, with the size-distribution of cloud elements and the transformation of ice to water and vice versa, matters of great concern in aviation as well as to the more academic meteorologist. All these problems are being tackled, in Britain and in other parts of the British Commonwealth, and there is little doubt that the union between radio and meteorology so happily begun under Sir Edward Appleton's chairmanship during the War has many mutual benefits to confer in the coming years.

P. A. SHEPPARD

SIGNIFICANCE OF THE AUSTRALOPITHECINÆ

IN 1924, the immature skull of a large ape-like primate was discovered in some lime workings at Taungs in the valley of the Harts River, South Africa. It was briefly described by Prof. R. A. Dart, who regarded it as representing an extinct race of apes intermediate between living anthropoid apes and man. To this extinct race he gave the name *Australopithecus africanus*. There followed a mild controversy on the interpretation of this fossil, but many anatomists quite properly preferred to wait before committing themselves to definite statements until a full and systematic report on the original remains should appear. Twelve years later, Dr. Robert Broom, who had decided to search for more remains of *Australopithecus*, paid a visit to a cave at Sterkfontein, near Krugersdorf. Here he found portions of skulls and jaws of a fossil primate similar to *Australopithecus* but (in his opinion) sufficiently distinct in some of its characters to be referred to a separate genus. He called it *Plesianthropus transvaalensis*. Then, in 1938, the remains of what were taken to represent still another type, called by Broom *Paranthropus robustus*, were brought to light at Kromdraai, two miles east of Sterkfontein. Thus there are now available for consideration three series of extinct ape-like primates from South Africa, which are believed to be representatives of one sub-family, the Australopithecinæ. Excellent casts of the skull of *Australopithecus* have been available in Britain for many years now, and during the course of his excavations since 1936 Dr. Broom has been extremely generous in distributing casts of most of the valuable material which he has collected. Thus anatomists in Britain have for some time had this sort of evidence before them. Now there has appeared the long-awaited report on the Australopithecinæ by Dr. Broom and Dr. Schepers[1]. In this monograph, which is abundantly illustrated and incorporates numerous comparative studies, Broom deals in considerable detail with the osteological material, while Schepers discusses the endocranial casts. Apart from the obvious fact that access to the original material is really necessary to complete the evidence on which to base a considered opinion, it is now possible, at least in general terms, to assess independently the significance of these remarkable fossils.

Dr. Broom has demonstrated beyond any doubt at all that the Australopithecinæ are extremely important for the study of human evolution, since they present an astonishing assemblage of simian and human characters. Such an assemblage, indeed, might well be postulated, entirely on indirect evidence, for hypothetical ancestors of the Hominidæ. Thus it should be said at the outset of this review that Dart's original interpretation of the *Australopithecus* material has in several respects been completely vindicated. Some of the most outstandingly human features of the Australopithecinæ are undoubtedly those of the teeth and jaws. In both the deciduous and permanent dentitions, the incisors and canines are of human rather than simian proportions and pattern. The deciduous premolars are quite similar to those of the human child, while the permanent premolars, though very large, have the distinctive human pattern. The permanent molar teeth, in spite of their size (which is exceeded only by male gorillas and certain large extinct apes such as *Sivapithecus giganteus*), also show some approach to man in the disposition of their cusps. The dental arcade forms a rounded curve as in man and not an elongated U-shape such as is characteristic of modern large apes. The nature of the wear of the teeth and the anatomy of the temporo-mandibular region show, also, that the teeth and jaws were used in human fashion. In contrast with the remarkably human features of the teeth, the skull as a whole resembles in its general proportions those of anthropoid apes; and in a number of details, for example, the great facial extension of the premaxilla, the contour of the mandibular symphysis, and the apparent absence of a foramen spinosum, it is entirely simian and departs widely from the human condition.

So far, then, the Australopithecinæ might perhaps be regarded as a group of extinct apes, somewhat similar to the gorilla and chimpanzee, in which the characters of the dentition had developed (possibly independently) along lines almost identical with those of human evolution. But Dr. Broom has also, in his indefatigable search, brought to light some most important fragments of limb bones, which allow, and even make probable, a much more startling interpretation of these fossil remains. For example, of *Paranthropus* there are available the lower end of the humerus, the upper end of the ulna, and the talus. Judging from casts and Dr. Broom's illustrations, the humeral and ulnar fragments are entirely similar to those of *Homo sapiens*. Indeed, anatomists without the full evidence before them might well be excused if they expressed scepticism at their association with the skull of *Paranthropus*. But Dr. Broom states explicitly that the skull, jaw, humeral and ulnar fragments and the talus were all obtained from one mass of bone breccia less than a cubic foot in size, and that nowhere in any of the same deposits have remains of *Homo* come to light. Thus there seems no reason to doubt that this extinct ape-like creature had upper limbs of human proportions (at least so far as the elbow region is concerned), and which were evidently not used for brachiation. On the other hand, the talus is a remarkably small bone—in its dimensions, so far as these can be measured on a cast, it falls well short of the minimum recorded for modern races of mankind (cf. the data for Japanese women reported by B. Adachi[2]). Compared with the humeral fragment (which presumably belongs to the same individual) the size of the talus indicates a disproportionately small tarsus—more so, indeed, than would be expected if *Paranthropus* used its hind-limbs for the bipedal mode of progression characteristic of man. Further, the unusual medial extent of the articular surface of the head of the bone seems to indicate a very considerable mobility at the sub-talar joint, while the truncated neck suggests the transference of the major component of the weight of the body to the fore-part of the foot, a feature which Morton[3] has shown to be characteristic of the type of foot found in the great apes and therefore different from the trend shown in human evolution.

Of *Plesianthropus* there have been found the capitate bone of the carpus and the lower end of the femur. The former confirms the evidence of the arm bones of *Paranthropus*, that the Australopithecine upper limb closely corresponded to the modern human type, for the capitate bone seems to come well within the range of variation shown in the Bushman[4]. The lower end of the femur is perhaps the most important of all these limb-bone fragments, and Dr. Broom infers from it that *Plesianthropus* "walked, as does man, entirely or almost entirely on its hind feet". From

the appearance of the femur as depicted in Dr. Broom's drawing of it, we are inclined to agree with his interpretation. But his description of this most important evidence is tantalizingly brief (it is confined to 34 lines !). Indeed, we could have wished that the author had dealt with all this limb material in much more detail. The illustrations, too, while they give a good general impression of the appearance of the bones, are not sufficiently accurate for comparative studies. For example, the text-figure of the *Paranthropus* talus, although stated to be natural size, actually represents the bone as somewhat larger than the cast. So much depends on this limb material for a proper assessment of the Australopithecinæ. Thus, when Broom states at the conclusion of his section that "at Sterkfontein there are deposits of breccia probably as extensive as those of Choukoutien, and we may confidently assert that these are likely to yield dozens of skulls and probably fairly complete skeletons of the Sterkfontein ape-man", we can only implore all those concerned to see that facilities are provided forthwith in order that systematic excavations can be continued without interruption.

In addition to the skeletal material of the Australopithecinæ, there were available for study the natural endocranial cast of *Australopithecus*, portions of endocranial casts (partly distorted) of *Plesianthropus*, and an endocranial cast of the left temporal region of *Paranthropus*. The study of endocranial casts of fossil man and apes always raises afresh the oft-debated question as to how far the sulcal pattern of the brain itself can really be inferred from them. Studies of endocranial casts of modern man and apes, and their direct comparison with the actual brains, have shown that in these forms attempts to delineate the sulcal pattern may be grossly misleading[4]. Dr. Schepers regards the conclusions drawn from such careful and objective studies as "pessimistic", and, of course, it may be true that, for some reason or other (and very conveniently for the palæontologist !), the convolutions of the brain were more faithfully impressed on the bony walls of the cranial cavity in fossil than in living species. Nevertheless, neurological anatomists will be surprised to find that Dr. Schepers has apparently been able not only to map out with confidence the sulcal pattern over the whole cerebral hemisphere of *Australopithecus* and *Plesianthropus*, but also to delineate no less than twenty-six separate cyto-architectural areas and to compare them in their relative extent with those of modern apes and man. Cortical physiologists may likewise feel inclined to demur at some of the inferences regarding functions such as speech, abstract thought and motor skill which, it is suggested, can be drawn simply from the examination of a cast of the inside of the skull. But Dr. Schepers, in the introduction to this section, makes his attitude perfectly plain, for he says : "In all attempts at representing these fossils in a reconstructed form, the method employed was that of claiming the maximum dimensions considered likely for the type. It is . . . much less satisfactory to hear that a new find of fossil material does *not* suggest any new hypothesis or does not corroborate evidence already at hand about a cognate theory, than to discover that at least someone is prepared to claim the maximum importance for his discovery. Such enthusiasm encourages criticism and comment, and is therefore to be recommended."

There may be some who doubt the propriety of preparing a scientific report with a bias of this kind, but at least it makes for lively reading. At the same time it does make it somewhat difficult for the reviewer not to appear in the role of the carping critic ; and any appearance of carping criticism in the present instance is certainly to be avoided, if only because it might seem (unintentionally) to belittle the importance of this fossil material of which, in fact, the importance can scarcely be exaggerated. Also, the thoroughness with which Dr. Schepers has pursued his studies, and his evident eagerness to squeeze every drop of information from his material (even when this is defective) must evoke the greatest admiration for his assiduity. The cranial capacity of *Australopithecus* is estimated at 500 c.c., and of *Plesianthropus* at 435 c.c. The cranial capacity of *Paranthropus* is judged to be as high as 650 c.c. ; but since this estimate is based on little more than the left temporal region of the skull, it is not easy to accept it without qualification. For the same reason, the contours of the reconstructed endocranial cast of *Paranthropus*, which are used for graphic comparison with casts of other primates, should probably be discounted as being too conjectural. Thus, so far as the absolute volume of the brain is concerned, the Australopithecinæ appear to fall well within the limits of the anthropoid apes. On the other hand, if, as Dr. Schepers surmises might be the case, the endocranial casts hitherto obtained happen by chance to represent the lower limits of variation, the cranial capacity of the Australopithecinæ may in its upper limits have transcended the range of variation found in modern large apes. Only the accession of further material can decide this point. But it remains a matter of very considerable interest that the volume of the Australopithecine brain *relative to the body size* (so far as this can be inferred in a very general way from fragments of the limb skeleton) does appear to have exceeded somewhat that of modern large apes.

Enough has been said in this review to indicate the intermediate position which many of the anatomical characters of the Australopithecinæ in their combination occupy in relation to apes and men. Whether on the basis of this morphological evidence the South African representatives of this sub-family, which have so far been found, may be assumed to bear any direct relation to the line of human evolution, depends partly on the geological age of their remains. The evidence for this hitherto rests almost entirely on faunistic data. Dr. Broom is now of the opinion that the presence of a primitive hyæna, *Lycyæna*, and of two species of sabre-tooth tigers, in the deposits at Sterkfontein signifies a date not later than Upper Pliocene, and that the Taungs site is probably still older, perhaps Middle Pliocene. But he specifically states that, as with the deposits at Kromdraai, it is quite impossible at present to determine the geological age with certainty. However, the importance of the Australopithecinæ is so great for the study of primate palæontology, and particularly human palæontology, that it becomes imperative to obtain more information about their antiquity. Even the skeletal remains, in spite of the magnificent work of Dr. Broom, still remain too scanty for firm conclusions regarding their significance. For Dr. Broom and Dr. Schepers they provide evidence for an assumption that the modern apes, and even the fossil apes of the *Dryopithecus-Sivapithecus* group, have no close relation to man (they are the result of a prolonged period of parallel development), and that the line of human evolution diverged from that of other primates so far back as Eocene times. On the other hand, the distinguished palæontologist, Dr. W. K. Gregory (who has also had

the opportunity of examining the original Australopithecine material) concludes[6] that "the evidence afforded by the morphology of the braincast and skull structure can hardly leave a well-founded doubt that the Australopithecine group were derived from the *Dryopithecus-Sivapithecus* stock", and that "although it is too much to expect that the close structural approach of *Plesianthropus* towards *Sinanthropus* will discourage those who cling hopefully to the myth of Eocene man, all the facts . . . tend to confirm the conclusions of [those] who regard man as the result of a morphological revolution which took place during the later Tertiary period".

Such a divergence of opinion among recognized experts only serves to emphasize the need for still more fossil material. In this connexion we would quote a remarkable statement by Dr. Broom: "When some wealthy man or corporation undertakes the systematic exploration of our deposits . . . I think one can safely affirm that within three or four years we will discover more of the origin of man than has been revealed during the past hundred. Practically all the discoveries described in the present work, except the Taungs skull, were made by me in about two years working almost single-handed. Not only had I to find all the specimens, I had to develop them out of the matrix, give all the descriptions and make all the drawings."

Dr. Broom is a veteran palæontologist unequalled to-day in experience and reputation. This monograph on the Australopithecinæ is a fitting climax to a long life devoted to palæontological research, and to a record of fossil-collecting which is quite unsurpassed for its rich discoveries. Moreover, with the preliminary work on *Australopithecus* contributed by Prof. Dart, he has very considerably enhanced the prestige of South African science in the eyes of the world generally. Surely one may express with some confidence the expectation that his magnificent contributions to the story of human evolution will be recognized by his fellow countrymen, to the extent that they will provide the funds and the facilities for the realization of his hopes for further discoveries at Sterkfontein and elsewhere. No greater service could be done to the study of human origins, and no more appropriate expression of gratitude could be made to Dr. Broom.

W. E. Le Gros Clark

[1] The South African Fossil Ape-Men: The Australopithecinæ. By Dr. R. Broom and G. W. H. Schepers. (Transvaal Museum Memoir No. 2.) Pp. 272+18 plates. (Pretoria: Transvaal Museum, 1946.)

[5] *Mitt. med. Fac. Kais.-Jap. Univ.*, **6**, 307 (1905).

[6] Morton, D. J., *Amer. J. Phys. Anthrop.*, **7**, 1 (1924).

[4] See Kaufmann, H., and Sauter, M., *Arch. Suisses d'Anthrop. gén.*, **8**, 161 (1939).

[3] See, for example, the most recent monograph on the subject, "Anthropoid and Human Endocranial Casts". By Pierre Hirschler. Pp. ix+150+11 plates. (Amsterdam: N. V. Noord-Hollandsche Uitgeversmij., 1942.) n.p.

[2] *Ann. Transvaal Mus.*, **19**, 339 (1939).

OBITUARIES

Mr. H. B. Maufe

It has been sad news indeed for many friends of Herbert Brantwood Maufe to hear of his unexpected death in London on May 8 at the age of sixty-six. Only a few days previously he had been speaking of an early return to Africa.

It had been an ambition of Maufe's parents that their son should engage in scientific research; and their wish was fully gratified. Alike at school and at Cambridge, Maufe distinguished himself. So early as 1896 we find him contributing with T. Sheppard to the *Glacialists' Magazine*. Thereafter he was caught up in the excitement aroused by P. F. Kendall's interpretation of glacial diversions of rivers in Yorkshire—as instanced in a description Maufe furnished with A. Jowett to the British Association at Bradford, 1900, to be expanded in 1904 in *Proc. Yorks. Geol. and Pœl. Soc.*

After joining the Geological Survey of the United Kingdom in 1901, Maufe was identified with particularly interesting work, both in Ireland and Scotland. In the former country, where he had the good fortune to work under G. W. Lamplugh and alongside W. B. Wright, his problems continued mainly glacial. His account with Wright of "The Pre-Glacial Raised Beach of the South Coast of Ireland" in the *Scientific Proceedings of the Royal Dublin Society*, 1904, is a classic. In Scotland he was originator of three great non-glacial conceptions, covering the cauldron subsidences of Glen Coe and Ben Nevis; the recumbent fold of Ballachulish; and the dyke swarms of Etive and Mull.

Maufe's recognition of the curvature of the Glen Coe boundary fault, which leads it to bend from north-west to north, south of Glen Coe, and of the significant association of this fault with an external granitoid intrusion, can clearly be recognized in notes he contributed to the Survey's "Summary of Progress" for 1904. The next point came to him early in the field season of 1905. One Sunday morning, when I climbed across from Loch Leven to visit him at Clachaig Inn, Glen Coe, Maufe told me of his new discovery. He had already seen enough on my side of our mutual boundary to show that north of Glen Coe both the fault and its attendant intrusion swing round to run approximately east-south-east. "If this be so," I exclaimed, "we are dealing with what Suess calls a cauldron subsidence, and the granite around it has spurted up like the liquor of a full bottle when the stopper settles home!" At that time eroded cauldron subsidences were an unknown phenomenon in world geology.

As regards the Ballachulish fold, Maufe wrote in the "Summary of Progress" for 1905: "The structure of the district [part of Glen Etive] is evidently that of a huge overfold, the limbs of which dip gently westwards and are at least 3 miles in length (from trough to crest). The quartzite which caps the hills also forms the floors of the valleys."

Maufe seems to have been the first among geologists to recognize the individuality of great swarms of parallel dykes that sometimes extend both ways from an igneous focus. His work in the West Highlands took him across the margins of two such swarms: the Etive swarm running north-north-east, of Devonian age; the Mull swarm running north-west, of Tertiary age.

Before severing his connexion with the Survey of Great Britain, Maufe was lent in 1905 to examine railway cuttings in Uganda. His account, issued as a "Colonial Report", 1908, contains much of value. So, too, does a description, written jointly with R. G. Carruthers, of a holiday research on "The Lower Palæozoic Rocks around Killary Harbour, Co. Galway and Co. Mayo". This last was communicated to the Dublin meeting of the British Association, 1908, and was reproduced more fully in the *Irish Naturalist*, 1909.

In 1910 Maufe was secured as director for the newly founded Geological Survey of Southern

Rhodesia. His loss at home was keenly felt; but when one looks back over the long history of the doyen of Geological Surveys, one must recognize among its most useful services the training it has given to men who have afterwards occupied important posts abroad. I have no special qualification to speak of Maufe's contribution to the development of Southern Rhodesia during 1910–35—though I watched with appreciation the output of maps, bulletins and other publications, and sympathized with my friend's enthusiasm concerning the Great Norite Dyke of his adopted country. I may, in conclusion, quote from the words of the acting High Commissioner, when in 1930 the latter received for transmission the Lyell Medal of the Geological Society: "Mr. Maufe has built up for himself a reputation for integrity which is recognized not only by his own staff, by the general Civil Service, by the mining companies in the Colony, but also by the community in general".

E. B. BAILEY

Prof. K. Martin

PROF. K. MARTIN died at Leyden on November 14, 1942, at the age of nearly ninety-one years. A long life, almost wholly devoted to scientific research (his first publication dates from 1873, the last one from 1941), was thereby finished.

Johannes Karl Ludwig Martin was born at Oldenburg in 1851; he studied geology at the Universities of Munich, Leipzig and Göttingen, at the latter of which he took his doctor's degree in 1874.

After the establishment of a chair of geology in 1876, Martin was appointed professor of geology, mineralogy, crystallography and palæontology at the University of Leyden on October 1, 1877, an appointment which he held until 1922. He was also director of the Rijksmuseum van Geologie en Mineralogie from 1878 until 1922. Among the collections of this institution he found the fossils collected by Fr. Junghuhn in Java, and they directed his attention to Dutch East Indian palæontology. So much pioneer work on the Tertiary fauna of Java has been done by him since that time that Rutten called him the Linnæus of the Javanese Tertiaries.

Martin studied fossils belonging to the most varied groups, from Foraminifera to Mammalia, but his principal work was on Mollusca, to which the greater part of two large monographs, "Die Tertiärschichten auf Java" (1879–80), and "Die Fossilien von Java" (1891–1922), and many smaller publications were devoted. Most of his publications appeared in the *Sammlungen des Geologischen Reichsmuseum*, which he founded in 1881. Though he was an eminent taxonomist, who made good, concise descriptions of hundreds of new species, and discovered the fossil occurrence of great quantities of recent species already described, his main object was to decide the age of the sediments from which the faunas he studied derived.

When in 1919 he published the comprehensive "Unsere palæozoologische Kenntnis von Java", Cænozoic molluscan faunas from some thirty localities in Java had been investigated, which he considered to be of Eocene, Lower Miocene, Upper Miocene, Pliocene and Quaternary age. Although subsequent investigations have shown that parts of these faunas —mainly those of which Martin had but very poor material—were not correctly dated, his opinion about the most important localities (for example, Nanggulan, Eocene; West Progo Mountains and Rembang, Lower Miocene; Tjilanang, Upper Miocene; Sonde, Pliocene) was corroborated by further investigations. These faunas have served as an important basis of comparison for the study of neogene molluscan faunas from almost the whole Indo-West Pacific region since.

Even after his eightieth birthday, Martin undertook the examination of the mollusca discovered in the asphalt of Buton Island. This fauna appeared to consist only of species new to science, thirty-five of which were described and figured by Martin. He could bring forward strong evidence for an Oligocene age of this fauna, which thus partly filled the gap existing hitherto between the Eocene and Lower Miocene faunas of the Dutch East Indies.

Under his direction the collections of the Leyden Museum of Geology and Mineralogy, from a modest beginning, became the most important of their kind in the Netherlands. Numerous valuable collections from the East Indies were sent to Martin as an outstanding authority, and by purchase and exchange many fine specimens were added. Moreover, the materials of his three journeys to the Dutch East and West Indies (1884–85, Surinam, Curaçao and Aruba; 1891–92, Moluccas; 1910, Java) enriched the Museum.

From the fine records of his travels his broad interest in ethnography and general natural history is also evident.

Martin took a keen interest in Lepidoptera. Mainly during the last twenty years of his life he brought together a fine collection of these insects from the neighbourhood of Leyden as well as from Madeira and several European regions to which he paid visits during his holiday trips. In this study he was assisted by his second wife, Mrs. Martin-Icke, who also had taken part in his investigations on the Tertiary mollusca of the Dutch East Indies.

All who met Prof. Martin were impressed by his charming personality and gripped by his lively way of narrating. I, myself, visited him for the first time in March 1939 and was astonished to hear him speak about his early investigations on Javanese palæontology about 1880 as if it were the other day.

A bibliography of Martin's publications, the best evidence of his many-sided activity, is to be found in volume 5 of the *Leidsche Geologische Mededeelingen*, which volume was issued on his eightieth birthday in 1931 and contains complete reviews of the stratigraphy and palæontology of the Dutch East and West Indies. A supplement to this bibliography, containing ten papers by Martin which appeared later than 1931, was published by Umbgrove (*Geologie en Mijnbouw*, N.S., 4, 93, footnote 4 (1942)).

C. O. VAN REGTEREN ALTENA

Dr. E. B. R. Prideaux

EDMUND BRYDGES RUDHALL PRIDEAUX died at his home, Upmoor, Canford Cliffs, Bournemouth, on May 8, a few months after his retirement from his post as reader in physical and inorganic chemistry in the University College of Nottingham.

He was born in Barbados in 1878 and educated at the Auckland Grammar School and at Canterbury College, New Zealand University, where he gained the M.A. degree. In 1901 he came to England and worked under Ramsay in London and later with Donnan at Liverpool. He was awarded the D.Sc. of the University of London for his work on fluorine

compounds. He held academic posts at the Heriot Watt College, Edinburgh, Battersea Polytechnic and University of Liverpool; he went to Nottingham in 1914.

Prideaux's researches ranged over the whole field of chemistry. He investigated Kauri resin while in New Zealand and discovered new compounds of fluorine and selenium. With Cuthbertson he made the first determination of the refractive index of gaseous fluorine; he studied the molecular volumes of phosphorus and the mercury halides, the dissociation constants of the phosphoric acids and of boric acid, and published the method of titration of boric acid in the presence of sodium chloride. Papers on the structure of the halides of the fifth, sixth and seventh groups of the periodic table, and "Coordination and Conjugation, the Mixed Bond, Definition and Rules", were valuable contributions to the development of modern views on molecular structure. With A. T. Ward he developed the first universal buffer mixture; he worked on indicators, diffusion and membrane potentials, and compounds of fatty acids with nitrogen bases. Other work ranged from the vegetable and animal plankton and photosyntheses by Algæ in sea water (with B. Moore and G. A. Herdman) to the corrosion of cement, the titration of pyridine, the dissociation constants of alkaloids and the kataphoresis of insulin. He published in all some ninety original papers. His best known books are his "Theory and Use of Indicators", "Problems in Physical Chemistry", the volumes "Phosphorus" and "Nitrogen" (with Herbert Lambourne) in Newton Friend's "Text-Book of Inorganic Chemistry" and "A Laboratory Course in Elementary Chemistry" (with F. C. Laxton); but he also published "A Survey of English Elementary Education" and wrote many articles on educational and scientific topics. His popular broadcast talks on scientific topics in the early days of the British Broadcasting Corporation were models of lucid exposition.

During the First World War, Prideaux assisted at the national shell-filling factory at Chilwell, especially in the analysis of nitrotoluenes.

Prideaux came of a family chiefly interested in the classics, and was highly literary in his tastes. He was a man of very wide interests, philosophic and economic as well as scientific. He will be remembered with affection by the many generations of students to whose interests he devoted his life. In 1908 he married Annie, elder daughter of Rowland Bramwell of Auckland, New Zealand, who, with one daughter, survives him.

Sir Charles Marston

Sir Charles Marston died at Bournemouth on May 21 at the age of seventy-nine. Sir Charles, who had for long been the head of extensive business interests connected especially with the motor industry, was a liberal supporter of archæological excavation in Egypt and the Middle East. He was also, himself, responsible for two important expeditions for archæological excavation in Palestine. Of these the first was Prof. John Garstang's excavation on the site of the ancient city of Jericho, which produced much new evidence on the activities of Egypt in Palestine in the days of Amenhotep III. His second expedition was directed to the exploration of the mound of Tell Duweir, identified as the site of the ancient city of Lachish. This expedition he organised and financed, in the first season with some assistance from America, and in its later stages with the co-operation of the late Sir Henry Wellcome. The excavation produced some remarkable results, throwing much new light on Hebrew history and culture from early times to the Assyrian and Babylonian incursions. The expedition was lavishly equipped for complete efficiency. Permanent camps and field laboratories were constructed with a view to the complete excavation of the mound, a task which it was anticipated would take many years. It was tragically interrupted. In January 1938, Mr. J. Starkey, the field-director, was assassinated by Arabs while on his way to Jerusalem, and shortly after the close of the season's operations the camp was wrecked and the equipment looted or destroyed, a total loss of many thousands of pounds.

Sir Charles's personal interests were bound up in Palestine. It was his hope and belief that archæological excavation would prove his intense conviction of the literal accuracy of the Bible to be correct. He was the author of several books, in which his view was ably stated and argued, though not always so as to carry conviction.

Dr. Simon Flexner

The death of Dr. Simon Flexner in New York on May 2, at the age of eighty-three, has deprived America of one of its best-known pathologists. He was born in 1863 at Louisville, Kentucky, and qualified at the University there in 1889. He soon made pathology his choice and studied at Johns Hopkins Hospital and in Europe, where he worked in Strasbourg, Paris and Berlin. At Johns Hopkins Hospital he became associate professor in 1895, and in 1898 professor of pathology. The next year he went to the University of Pennsylvania until 1903, when at the age of forty he was appointed director of the Rockefeller Institute for Medical Research in New York. It was here that he became best known and remained for thirty-two years before retiring in 1935.

Flexner's name is associated with many diseases—dysentery, poliomyelitis, cerebrospinal fever and encephalitis. In 1900 he showed in the Philippines that one form of bacillary dysentery is due to an organism that has always been associated with his name. With poliomyelitis he showed very shortly after the Vienna work that the disease was transmissible to monkeys and was due to a virus. Flexner and his colleagues did much to elucidate the pathology of this condition. He advanced the theory that the infection was carried by droplets from the nasopharynx, and in spite of other views it still seems to be the most valid. In meningococcal meningitis he made important therapeutic advancement, producing with Jobling an antimeningococcal serum that reduced the high death-rate of this epidemic disease; a very notable advance indeed.

It is not so much by his personal achievements that he will be remembered, however, but by the great influence he exerted on all who worked at the Rockefeller Institute for Medical Research. I had the privilege of working directly under him during 1922–23. He was guide, philosopher and friend to all his associates. He was never too busy to advise, criticize and help his most junior workers. He hated dishonesty and laziness, and had no use for the shirker or slacker. He had a keen intellect, a vast knowledge of his subject, and a personality that inspired work and confidence in his associates. He

knew everyone in the Institute from the humblest cleaner upwards, and had a kindly greeting for all. He was familiar with the progress of all the numerous workers in the Institute, and could instantly grasp their problems and help elucidate their difficulties whenever they came to him for assistance.

As editor of the *Journal of Experimental Medicine*, Flexner exerted a keen critical and literary control, and woe betide any paper that was sent to him which was not up to the high standards which he set for that journal. His blue pencil, however, was constructive and taught many lessons. Outside his work he was a most charming host with an encyclopædic knowledge of many subjects and of different parts of the world. He leaves kindly memories with all those who were associated with him.

J. E. McCartney

We regret to announce the following deaths:

Dr. M. Epstein, editor of "The Statesman's Yearbook" and "The Annual Register", on June 23, aged sixty-six.

Prof. T. H. Laby, F.R.S., during 1915–44 professor of natural philosophy in the University of Melbourne, aged sixty-six.

Prof. William Peddie, during 1907–42 Harris professor of physics in University College, Dundee (University of St. Andrews), on June 2, aged eighty-five.

Dr. A. W. Rogers, F.R.S., formerly director of the Geological Survey of South Africa, aged seventy-four.

Dr. H. E. Wood, for many years Union astronomer and director of the Union Observatory, Johannesburg, on February 27, aged sixty-five.

NEWS and VIEWS

Prof. C. L. Fortescue

Prof. C. L. Fortescue, who is retiring at the end of the present academic year from the chair of electrical engineering in the Imperial College of Science and Technology, went to the City and Guilds (Engineering) College, a constituent body of the Imperial College, in 1922 with a background of electrical engineering, radio and teaching experience obtained largely with the Admiralty and at the Royal Naval College, Greenwich. In addition to maintaining the traditions of the City and Guilds College in the general field of electrical engineering, Prof. Fortescue has successfully developed the radio and general communications sections, the foundations of which were laid by the pioneer work of Duddell, Howe and Marchant. During the past twenty years or so, this provision of adequate education and fundamental training in the lighter side of electrical engineering has coincided with the rapid and widespread application of radio and audio-frequency techniques to communication, broadcasting, cinemas, radar and navigational aids. A surprisingly large proportion of the radio and sound engineers now working in industrial and other types of establishments in Great Britain and elsewhere owe their initial instruction and training in these fields to Prof. Fortescue and his colleagues at the Imperial College.

In addition to orienting a portion of the College syllabus towards telecommunications, Prof. Fortescue has been very active in the radio research field, with particular reference to the use of thermionic valves and measuring technique at increasingly higher frequencies. This work started during his service with the Admiralty before and during the First World War, and has been continued at the Imperial College, both as a personal effort and in association with a series of post-graduate students, who have thus been provided with unusual opportunities for securing training in research under a very able leader and adviser. The results of much of this research work have been published in a series of papers, notably in the *Journal of the Institution of Electrical Engineers*: this Institution has recognized Prof. Fortescue and his achievements by electing him chairman of the Radio (then Wireless) Section in 1926 and president of the Institution in 1942. He has also served on the council of the Physical Society and been associated from time to time with the Radio Research Board of the Department of Scientific and Industrial Research.

Prof. Willis Jackson

Prof. Willis Jackson, who has recently been appointed to succeed Prof. C. L. Fortescue as head of the Electrical Engineering Department at the Imperial College of Science and Technology, has occupied the chair of electrotechnics at the University of Manchester since 1938. He graduated there in 1925, and after a period at Bradford Technical College joined the Metropolitan-Vickers Electrical Co., Ltd., and afterwards Prof. Miles Walker's staff at the College of Technology, Manchester. During 1933–36 he worked with Dr. E. B. Moullin in the Engineering Laboratory, Oxford, and then spent a period as personal assistant to Sir Arthur Fleming in the research department of Messrs. Metropolitan-Vickers. He served as a member of council of the Institution of Electrical Engineers during 1939–42, was re-elected in 1945, and is now chairman-elect of its Radio Section. He is also a member of the Radio Research Board (Department of Scientific and Industrial Research). His research work prior to the War, and during it on behalf of the Ministry of Supply, was concerned mainly with the behaviour of dielectric materials, to which subject, as also in the field of very high-frequency measurements for radar purposes, he has made important contributions. He has also published several papers dealing with the education and training of engineers, and his interest in general, as well as technical, education has been recognized by the Ministry of Education in appointing him a member of its Central Advisory Council for England.

U.S. National Academy of Sciences

The following have been elected members of the U.S. National Academy of Sciences: Dr. Samuel K. Allison, director, Institute for Nuclear Studies, University of Chicago; Dr. Rudolph J. Anderson, Department of Chemistry, Yale University; Dr. Ernest B. Babcock, Department of Genetics, University of California, Berkeley; Dr. Kenneth T. Bainbridge, Department of Physics, Harvard University; Dr. Elmer K. Bolton, director, Chemical Department, E. I. duPont de Nemours and Company, Wilmington, Delaware; Dr. Wilmot H. Bradley, chief geologist, United States Geological Survey; Dr. Perry Byerly, Department of Seismology, University of California, Berkeley; Dr. Paul R. Cannon, Department of Pathology, University of Chicago; Dr. Milislav

Demerec, director, Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor; Dr. Jesse Douglas, Department of Mathematics, Brooklyn College; Dr. Clarence H. Graham, Department of Psychology, Columbia University; Dr. Morris S. Kharasch, Department of Chemistry, University of Chicago; Dr. Karl Paul Link, professor of biochemistry, Agricultural Experiment Station, University of Wisconsin; Dr. Robert F. Loeb, College of Physicians and Surgeons, Columbia University; Dr. Esmond R. Long, Henry Phipps Institute, 7th and Lombard Streets, Philadelphia, Pa.; Dr. Joseph E. Mayer, Department of Chemistry, Columbia University; Dr. Charles S. Piggot, Geophysical Laboratory, Carnegie Institution of Washington; Dr. Marcus M. Rhoades, Department of Botany, Columbia University; Dr. George Scatchard, Department of Chemistry, Massachusetts Institute of Technology; Dr. Tracy M. Sonneborn, Department of Zoology, Indiana University; Dr. Leslie Spier, P.O. Box 880, Santa Cruz, California; Dr. S. Smith Stevens, Department of Psychology, Harvard University; Dr. Chauncey G. Suits, director of the Research Laboratory, General Electric Company, Schenectady, New York; Dr. Frederick E. Terman, dean of the School of Engineering, Stanford University; Dr. Merle A. Tuve, director of the Department of Terrestrial Magnetism, Carnegie Institution of Washington; Dr. Chester H. Werkman, head of the Department of Bacteriology, Iowa State College; Dr. Roger J. Williams, director of the Biochemical Institute, University of Texas; Dr. Frank C. Whitmore, dean of the School of Chemistry and Physics, Pennsylvania State College; Dr. Wendell P. Woodring, principal geologist, United States Geological Survey.

The following have been elected foreign associates of the National Academy of Sciences: Prof. Sydney Chapman, Sedleian professor of natural philosophy, University of Oxford; Dr. Peter Kapitza, director of the Institute for Physical Problems, Academy of Sciences of U.S.S.R.

National Research Council of Canada: Medical Fellowships

POST-GRADUATE medical fellowships have been awarded for 1946–47 by the National Research Council of Canada for the first time. Three junior awards (1,200 dollars a year) and five intermediate awards (1,800 dollars a year) have been announced: provision has also been made for senior awards (2,400 dollars a year). Junior fellowships are open to graduates in medicine who have already completed one year of post-graduate study; intermediate fellowships to applicants who have had experience in research work in a medical science for at least one year following graduation; senior fellowships are for applicants who have given evidence of capacity to conduct independent research in medical science. The awards for 1946–47 are as follows: *Junior Fellowships:* Dr. M. Hendelman (McGill), at the Royal Victoria Hospital, Montreal (obstetrics and gynæcology); Dr. Levitan (McGill), at McGill University (physiology); Dr. D. L. Wilson (Queen's), at the University of Toronto (biochemistry). *Intermediate Fellowships:* Dr. P. Dontigny (Laval and Montreal), at the Institute of Experimental Medicine and Surgery, Montreal (endocrinology); Dr. A. Gold (McGill), at McGill University (endocrinology); Dr. J. Leger (Montreal), at the Institute of Experimental Medicine and Surgery, Montreal (endocrinology and allergy); Dr. K. R. Mackenzie (McGill), at the University Clinic, Royal Victoria Hospital, Montreal (experimental medicine); Dr. G. C. McMillan (McGill), at the Pathological Institute, McGill University (pathology).

Indian Statistical Institute

AT the fourteenth annual general meeting of the Indian Statistical Institute, held on April 27 in Calcutta, the following officers were elected for the session 1946–47: *President*, Sir C. D. Deshmukh; *Hon. Vice-Presidents* (having filled the office of president), Sir Badridas Goenka, Mr. N. R. Sarker; *Vice-Presidents*, Dr. P. N. Banerjea, Sir A. H. Ghuznavi, Sir T. E. Gregory, Dr. S. P. Mookerjee, Sir C. W. B. Normand, Mr. Chandmull Rajgharia, Sir Shri Ram, Sir C. V. Raman, the Hon. Justice T. J. Y. Roxburgh, the Hon. H. S. Suhrawardy; *Treasurer*, Dr. Satya Churn Law; *Secretary*, Prof. P. C. Mahalanobis (on leave), Prof. S. N. Bose (to act in his place); *Joint Secretaries*, Prof. K. N. Chakravorti, Kumar Bimal Chandra Sinha.

As in previous years, the Indian Statistical Institute has continued during the past year its usual activity along various lines of theoretical and applied research. It undertook and carried out various types of statistical surveys, among which may be mentioned a comprehensive crop survey in Bengal covering jute, Aus paddy, and Aman paddy, population forecasts, and inquiries relating to the economics and statistics of road development projects, the economic condition of agricultural labour in Bengal, rural indebtedness, and the family budget of middle class employees in Bengal. A sample survey of the after-effects of the Bengal famine of 1943 undertaken by the Institute in collaboration with Prof. K. P. Chattopadhyaya of the University of Calcutta mainly from the point of view of rehabilitation culminated in a comprehensive paper on the subject recently published. Government servants from many parts of India and students from various universities received training at the Institute. A special course in industrial statistics was also instituted last year and was largely attended. Prof. P. C. Mahalanobis, honorary secretary of the Institute, has recently been carrying out work in New York for the United Nations Organisation and is now taking part in the Royal Society Empire Scientific Conference being held in Great Britain.

Radiobiological Research

A RECENT number of the *British Medical Bulletin* (Vol. 4, No. 1, 1946. 7*s*.) is entitled "Radiobiology, Experimental and Applied". This volume is the second of a series concerned with the applications of physics in medicine and contains twelve reviews. The subjects include most of the problems of contemporary interest in relation to the scientific basis of radiotherapeutics. The introductory article by Dr. F. G. Spear summarizes the whole field of radiobiological research and includes an instructive plate illustrating the relationship between cell division and cell differentiation in normal tissues. Dr. L. H. Gray contributes a valuable review of the influence of 'linear ion density' (specific ionization) on the relative biological efficiency per ion pair. The genetic effects of radiations are lucidly summarized by Dr. D. G. Catcheside. The article by Dr. D. E. Lea on the action of radiation on viruses and bacteria is an only too brief survey of a subject to which he has so largely contributed. Radiotherapists will be especially

interested in the review by Dr. A. Glücksmann entitled "Quantitative Histological Analysis of Radiation-Effects in Human Carcinomata". The measurement of radiation is discussed by Dr. G. J. Neary in a manner interesting to biologists. Dr. Frank Ellis writes on total energy absorption in radiotherapy and includes much information of practical value. Dr. J. Read summarizes the most important technical methods in use in X-ray therapy, and Prof. S. Russ discusses technical methods in radium therapy. Mr. G. S. Innes reviews the subject of one million volt X-ray therapy and concludes that the "physical and clinical results are such that they lend support to the view that a further increase in voltage to the 5 to 10 million volt range is likely to give still better clinical results". Protective methods in radiology are of great interest at the present time and are discussed in some detail by Mr. W. Binks. A final short article by Dr. J. Read describes the scheme developed by the Association of Hospital Physicists for the exchange of diagrams and data between radiotherapy centres.

Land Use in Cyprus

A CONFERENCE on "Land Use in a Mediterranean Environment" was held in Nicosia, Cyprus, during April 16–17 under the chairmanship of the Colonial Secretary, Mr. R. E. Turnbull. In addition to senior officers of the Cyprus Government Departments interested in land use—agriculture, forests, water, co-operation and land registration and survey—and a number of Cypriot non-officials representing farmers' organisations, there were present Dr. R. O. Whyte, director of the Imperial Bureau of Pastures and Forage Crops, and six officers from Palestine Government Departments connected with land and its use. Mr. Turnbull, in opening the conference, explained that it had been organised as a result of a visit which Dr. Whyte had made in the autumn of 1945, in the course of which he had formed the opinion that there was in Cyprus a fund of technical knowledge and practical experience on a number of subjects connected with land use which could with benefit be brought out at such a conference. Papers, each followed by a general discussion, were read on: land use in relation to the climate and topography of Cyprus (J. MacDonald, director of agriculture); State forests and their role in the island's land-use economy (R. Waterer, conservator of forests); water control in Cyprus (A. Cawley, assistant water engineer); forest grazing (G. Chapman, assistant conservator of forests); tenure and inheritance of immovable property in Cyprus and the 1946 reforms (P. Christodoulou, Department of Land Registration and Survey); development of co-operation in Cyprus (R. Henry, registrar of co-operative societies); soil fertility in the arable lands of Cyprus in relation to land use (L. Littlejohn, Department of Agriculture); trees and their place in village land use and development (T. Couppis, assistant conservator of forests); animal husbandry in relation to land use and environment (J. Maule, Agricultural Department). It is hoped to publish the proceedings of the conference shortly.

Astronomical Work in Spain

A RÉSUMÉ has been issued of the observations of solar prominences made at Madrid during 1941 (*Bol. Astron. Observ. Madrid*, **3**, No. 2; 1944). The observations were conducted by E. Gullón with the 20-cm. Grubb equatorial, focal length 3 metres, equipped with a Zeiss spectroscope. Observations of sunspots made at the Observatories of Madrid, Valencia and Cartuja (Granada) in 1941 are given graphically in six diagrams, each diagram showing a separate graph for each of the observatories. M. Martín Lorón provides a table showing the results of observations of occultations of stars by the moon during the years 1941, 1942 and 1943. The reduction of the observations was effected by Comrie's method which appeared in the "Supplement to the Nautical Almanac", 1938. No. 3 of the *Boletin* continues the record of sunspots for the year 1942, and contains separate sections on three remarkable solar prominences observed in 1936 by Enrique Gullón at the Observatory of Madrid; on the observations of Mars during the opposition of 1939, by Enrique Gullón and Mariano Martín Lorón; and on occultations during 1944, by M. Martín Lorón.

Map of Hispanic America

THE task of compiling a map of Hispanic America on a scale of 1 : 1,000,000 which was undertaken by the American Geographical Society, of New York, in 1920 has now been completed by the publication of the 107th Sheet. This is regarded as a provisional issue of the international 'million' map in which in 1913 thirty-five governments agreed to participate. The original plan embraced the production of 974 sheets to cover the continental land masses and the larger islands, exclusive of polar regions. By 1938 a total of 405 sheets had been published, of which, however, only 232 could be voted as standard. Of these sheets, a large number were the American Society's sheets of South and Central America, in which areas only Brazil and the Argentine Republic had contributed any part of their respective shares in the international scheme. In Brazil the production was rapid and went far, but was not a government undertaking, and the sheets fell short of the standard scheme. Of the three Argentine sheets, no general printing seems to have been undertaken. In the *Geographical Review* of January there is a full account of the map of Hispanic America and some of the problems encountered.

South-Eastern Union of Scientific Societies

THE first congress of the South-Eastern Union of Scientific Societies was held in April 1896 at Tunbridge Wells; it is therefore appropriate that, in the year of its jubilee, the annual congress should return to Tunbridge Wells. During the War one-day congresses were held to preserve continuity, and the Union is marking the return to normal procedure and also its jubilee by a five-day congress, July 9–13, under the presidency of Prof. J. D. Bernal, whose address will be entitled "The Place of Scientific Societies in the New World". The sectional presidents are Mr. E. Yates (archæology), Prof. W. H. Pearsall (botany), Dr. J. C. M. Given (geology), and Dr. E. Hindle (zoology). The Alexander Pedler Lecture of the British Association will be delivered on July 11 by Dr. O. J. R. Howarth, who will speak on "Charles Darwin's Life at Downe, Kent". In order to mark the jubilee of the Union, Miss M. S. Johnston has prepared a brief account of its history; and a survey, "Royal Tunbridge Wells, Past and Present", edited by Dr. J. C. M. Given, which includes chapters on Wealden geology, history of the neighbourhood, the Wealden iron industry and local natural history, will be available (Pp. 183. Courier Printing and Publishing Co. Ltd. 5*s*.)

Chemical Society: Centenary Celebrations

THE Council of the Chemical Society proposes to celebrate during July 15–17, 1947, the centenary of the foundation of the Society, which was due in 1941. Many distinguished overseas chemists are being invited. It is hoped to arrange a series of special events, both social and scientific, which will include an exhibition to illustrate the Society's history. An Executive Committee to make arrangements for the celebrations has been set up with Prof. C. N. Hinshelwood, president of the Society, as chairman, and Dr. D. C. Martin, general secretary of the Society, as secretary. It is anticipated that the Eleventh International Congress on Pure and Applied Chemistry will take place immediately following the centenary celebrations of the Chemical Society.

University of Leeds: Appointments

THE following appointments have recently been made: Dr. R. H. Evans, reader in civil engineering, to be professor of civil engineering; Dr. H. V. Dicks, to be whole-time professor of psychiatry; Dr. W. S. Craig, to be whole-time professor of pædiatrics and child health; Dr. F. S. Fowweather, reader in chemical pathology, to be professor of chemical pathology; Dr. J. Gordon, senior lecturer in bacteriology, to be reader in clinical bacteriology; Dr. K. I. Johnstone, lecturer in bacteriology, to be reader in public health bacteriology; Mr. Robert Brown, to be senior lecturer in botany; Mr. D. Appleyard, to be lecturer in mechanical engineering; Mr. G. Wilson, to be lecturer in civil engineering.

Comet Timmers (1946*a*)

ORBITS of this comet have been computed by Dr. G. Merton and Dr. M. Davidson, the former a parabolic orbit and the latter a general orbit. The elements are practically the same and the comet must have a very long period—about 21,000 years according to Dr. Davidson. The orbit and ephemeris computed by Dr. Merton are given below. As the comet is receding from the earth and sun it is becoming fainter.

T	1946, April 13·40025 U.T.	
ω	54° 24′ 29·5″	1946·0
Ω	128 54 12·2	
i	72 49 25·0	
q	1·723417	

EPHEMERIS

1946	α 1946·0 h m	δ 1946·0	r	ρ
June 29	14 36·3	74° 22′	1·988	1·981
July 3	14 49·0	72 29		
7	15 00·2	70 29	2·040	1·997
11	10·3	68 25		
15	19·5	66 17	2·095	2·016
19	28·1	64 05		
23	36·2	61 48	2·153	2·043
27	43·8	59 29		
31	51·0	57 08	2·214	2·078

The Night Sky in July

FULL moon occurs on July 14d. 09h. 22m. U.T. and new moon on July 28d. 11h. 53m. The following conjunctions with the moon take place: July 1d. 19h., Venus 3° S.; July 3d. 07h., Mars 4° S.; July 6d. 11h., Jupiter 4° S.; July 31d. 15h., Venus 5° S.; July 31d. 23h., Mars 5° S. Occultations of stars brighter than magnitude 6 are as follows, in the latitude of Greenwich: July 7d. 20h. 37·3s., $\varkappa$ Virg. (*D*); July 11d. 21h. 19·5m., *b* Ophi. (*D*); July 18d. 01h. 17·1m., 69 Aquar. (*R*). Mercury can be seen in the western sky in the early portion of the month, but later on it is too close to the sun for favourable observation. The planet attains its greatest western elongation on July 5 and is stationary on July 19. Venus sets at 22h. 16m. and 21h. 15m. at the beginning and end of the month respectively, and is conspicuous in the western sky. The stellar magnitude of the planet is − 3·5 in the earlier portion, and − 3·6 in the later portion, of the month. Mars sets 2¼ hours after the sun on July 1, but at the end of the month only 1¼ hours after the sun and is not well placed for observation in the latter case. Jupiter, near θ Virginis, sets at midnight on July 1 and about 1½ hours after the sun on July 31. The stellar magnitude of the planet varies from − 1·7 to − 1·5 during this period. Saturn is drawing in too close to the sun for favourable observation. The earth reaches aphelion on July 3d.

Announcements

IN the King's Birthday honours list it is announced that Mr. Charles S. Wright, director of scientific research, Royal Naval Scientific Service, has been appointed K.C.B.

THE Nutrition Society, with the assistance of the British Council, has arranged an "Informal Post-War Conference of European Nutritionists" to be held during the period July 4–20. Open meetings will be held at the London School of Hygiene and Tropical Medicine on July 5, 6 and 8. It is hoped by arranging these meetings to enable research workers from countries occupied by the Germans to re-establish contacts in Great Britain, and to describe nutritional research in Europe during the war period.

THE Cambridge University Press announces a new series of monographs dealing with the advances in radio techniques made during war-time. Mr. J. A. Ratcliffe is the general editor. Nine such books are now in active preparation; of which two, "Radio Navigation Devices" by Dr. R. A. Smith, and "Velocity Modulated Electron Tubes" by Mr. A. H. Beck, are complete and will go into production immediately. Another new series, "Monographs on Modern Nuclear Physics", under the general editorship of Prof. N. Feather, of the University of Edinburgh, is also announced. The first six will be by Dr. S. Devons, Prof. Feather, Dr. N. Kemmer, Prof. P. B. Moon, Mr. J. Dainty, and Dr. O. R. Frisch. In planning these monographs, the requirements of the advanced student, as well as those of the research worker, have been kept in mind.

DR. E. ASHWORTH UNDERWOOD, director of the Wellcome Historical Medical Museum, 183/193 Euston Road, London, N.W.1, states that a catalogue of the extensive library of the Museum is being prepared, but that it will be some time before this work will be published. Meanwhile, if anyone who is preparing a bibliography of the works of any writer in the field of medicine or the allied sciences desires to include the location of known copies of the different works, Dr. Underwood will be pleased to send him a list of the various works and separate editions of that writer which are in the library of the Wellcome Historical Medical Museum, and applications should be made to him in writing. It is hoped to open the library for the use of students at an early date.

ERRATUM. In the communication entitled "Structure of the So-called *cis* Decalin" in *Nature* of June 8, p. 765, Fig. 1*a* is incorrectly described; it shows the *trans* decalin structure accepted by Mohr and by Bastiansen and Hassel.

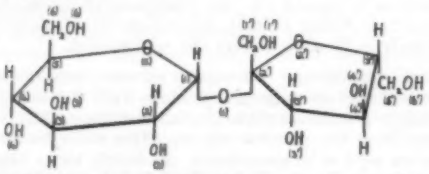
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

X-Ray Examination of Sucrose

ALTHOUGH the chemical structure of most sugars has been established beyond doubt, a given chemical structure may comprise several geometrical possibilities. In particular, the exact conformations of the pyranose and furanose rings, which are of general occurrence in sugars and sugar derivatives, have long been the subject of speculation. An X-ray investigation of a series of sugars and their methyl derivatives was made by Cox, Goodwin and Wagstaff[1], who came to the conclusion that the five carbon atoms of the pyranose ring lie in a plane but the oxygen atom is raised out of this plane. That this conclusion is not of universal application was shown by Cox and Jeffrey[2], who determined the positions of all the atoms (other than hydrogen) in the crystal lattice of glucosamine hydrobromide, and were thus able to prove that in this case the pyranose ring is of the Sachse *trans*-form. Cox and Goodwin[3] have suggested that the four carbon atoms and one oxygen which comprise the furanose ring are coplanar, but direct evidence has hitherto been entirely lacking. The sugars thus merit further attention by the methods of X-ray crystallography.

The structure of the sucrose molecule is of especial interest for three main reasons: (1) The chemical evidence that sucrose consists of a glucose residue linked to a fructose residue through an oxygen atom may be regarded as conclusive, but there is no direct evidence as to whether the α- or β-form of either hexose is involved in the linking at the biose junction. Indirect evidence favours an α-configuration for the glucose residue and a β-configuration for the fructose residue, so that sucrose should probably be represented by the accompanying formula. (2) One half of the molecule is based on the pyranose ring, the other on the furanose ring. A determination of the positions of the atoms within the sucrose molecule would therefore give direct evidence as to the conformations of both rings. (3) The fact that sucrose has not yet been synthesized casts a trace of doubt on the accepted formula.



An attempt to determine the crystal structure of sucrose itself by direct (Patterson–Harker) methods was unsuccessful. Attention was therefore transferred to certain addition compounds which sucrose forms with inorganic salts, notably with the halides of sodium. There can be little doubt that in these compounds the organic molecule acts as a single unit and preserves its internal structure unchanged, except possibly for a change in the relative orientation of the component residues due to rotation about the bonds joining them to their common oxygen atom. The isomorphous substances $C_{12}H_{22}O_{11}.NaBr.2H_2O$ and $C_{12}H_{22}O_{11}.NaCl.2H_2O$ have been briefly described by one of us (W. C.) in a recent communication[4]. We have made use of this isomorphism to determine the complete crystal structure of sodium bromide sucrate by Patterson and Fourier methods. The maps of the electron density obtained in this way may have been improved by 'trial and error' methods, and the final maps of electron density projected on (001) and (010) are sufficiently accurate to distinguish with certainty between carbon and oxygen atoms. It may therefore be claimed that the results given below are based entirely on the X-ray data and are independent of stereochemical assumptions. The following is a description of the structure: space group $P2_12_12_1$, $a = 21{\cdot}92$, $b = 9{\cdot}72$, $c = 8{\cdot}43$ A., cell containing four molecules of $C_{12}H_{22}O_{11}.NaBr.2H_2O$ on $(x\ y\ z)$ $(\frac{1}{2}-x,\ \bar{y},\ \frac{1}{2}+z)$ $(\bar{x},\ \frac{1}{2}+y,\ \frac{1}{2}-z)$ $(\frac{1}{2}+x,\ \frac{1}{2}-y,\ \bar{z})$.

Parameters in 60ths of cell edges

Br	(3·9	10·6	3·1)	$CH_2(1')$	(15·0	56·0	38·0)
Na	(4·4	28·3	7·5)	OH(1')	(15·8	48·3	33·8)
CH(1)	(11·2	12·8	36·0)	C(2')	(10·9	58·0	38·0)
O(1)	(10·3	6·3	42·0)	O(2')	(9·5	57·0	28·6)
CH(2)	(13·2	19·2	41·5)	CH(3')	(8·5	52·8	43·4)
OH(2)	(16·2	16·6	45·8)	OH(3')	(8·4	54·0	53·5)
CH(3)	(10·4	23·5	47·6)	CH(4')	(5·2	51·8	37·8)
OH(3)	(12·3	30·2	51·8)	OH(4')	(3·0	44·5	40·8)
CH(4)	(7·2	26·5	43·0)	CH(5')	(6·5	51·4	28·1)
OH(4)	(4·4	30·0	49·0)	$CH_2(6')$	(4·0	54·1	21·1)
CH(5)	(5·4	19·0	37·3)	OH(6')	(1·8	0·8	22·9)
O(5)	(8·1	15·8	30·2)				
$CH_2(6)$	(2·0	22·0	31·0)	$H_2O(1)$	(10·6	23·5	14·0)
OH(6)	(3·3	28·0	24·5)	$H_2O(2)$	(7·9	40·7	5·0)

These results confirm the formula given above. In particular, the oxygens attached to carbons 1 and 2 of the pyranose ring, O(1) and OH(2), are in *cis*-positions, and those attached to carbons 2' and 3' of the furanose ring, O(1) and OH(3'), are in *cis*-positions. Sucrose may therefore be described as 1-α-glucopyranose-2-β-fructofuranose. The pyranose ring is of the Sachse *trans* (chair-shaped) form, interatomic distances and angles being normal within the limits of experimental error (estimated at $\pm$ 0·05 A., $\pm$ 5°, respectively). The five atoms of the furanose ring are definitely not coplanar, but the departure from planarity appears to be in the interests of a more general approach to flatness of the residue as a whole, the carbon atoms (3'), (4') and (5') being displaced in such a way as to bring their attached groups more nearly into the mean plane of the ring. Within the ring the mean C—C distance is 1·44 A., and the mean inter-bond angle is 104°. These differ from the normal aliphatic C—C distance (1·54 A.) and the tetrahedral angle (109½°) by an amount which is too great to be due entirely to experimental error.

The disposition of sodium and bromine ions is also of interest. Each sodium is close (2·93 A.) to one bromine only, and in addition is in contact with two water molecules and three hydroxyls. This six-fold co-ordination around sodium possesses almost regular octahedral symmetry. The bromine ion also has six-fold co-ordination, but this is much less regular. If bonds are regarded as being directed from positive to negative regions of the structure, each hydroxyl has one incoming and one outgoing bond, while each water molecule has two incoming and two outgoing bonds. This is in agreement with the concept of polarized OH groups and the Bernal–Fowler model[5] of the water molecule, except that the tetrahedral distribution of the water molecule bonds cannot be said to be even approximately regular. There are only two direct intermolecular bonds between OH groups themselves; the remainder may be regarded as linked through the bromine and sodium ions and the two water molecules.

It is hoped to publish a fuller account of this work elsewhere.

C. A. BEEVERS
W. COCHRAN

Dewar Crystallographic Laboratory,
Chemistry Department,
University, Edinburgh.

[1] Cox, E. G., Goodwin, T. H., and Wagstaff, A. I., *J. Chem. Soc.*, 1495 (1935).
[2] Cox, E. G., and Jeffrey, G. A., *Nature*, **143**, 894 (1939).
[3] Cox, E. G., and Goodwin, T. H., *J. Chem. Soc.*, 1844 (1932).
[4] Cochran, W., *Nature*, **157**, 231 (1946).

Focusing of Electrons in Two Dimensions by an Inhomogeneous Magnetic Field

FOR the focusing of β-rays two essentially different methods have hitherto been used, namely, the semicircular and the lens methods. It will be remembered that the former of these methods has a focusing action only in one plane, which means a greatly reduced intensity in comparison to the lens method. The latter procedure does not utilize the central part of the beam in the focusing, since the resolving power is proportional to the diameter of the central shutter. The lens method cannot, without the use of a special twisted shutter system, separate positive and negative electrons.

It can be shown, however, that several of the useful properties of the two focusing principles can be combined by using an inhomogeneous magnetic field of cylindrical symmetry with an electron path perpendicular to the lines of force and with double or two-directional focusing[1]. Similar problems of focusing arise in the construction of cyclotrons and betatrons.

A magnetic field which has cylindrical symmetry with respect to the direction z and which is symmetrical with respect to a plane $x-y$ orthogonal to z, is completely determined by the value of its strength $H(r)$ along a radius $OP = r$ in the said plane. A charged particle (e,m) may have a stationary motion with the velocity v in a circular path (radius r_0) in the $x-y$ plane if the equation

$$H(r_0) = \frac{mv}{er_0}$$

is satisfied.

The conditions for the stability of the motion are expressed by the requirement that the so-called focusing angles assume real values. If the initial direction of the particle is included in the $x-y$ plane but differs somewhat from the direction of the tangent of the stationary path (the central line), then the path of the particle will return to the central line after having covered a distance expressed by the azimuthal angle Φ_r, the *radial* focusing angle. If the deviation from the initial direction occurs in the z direction we have, correspondingly, an *axial* focusing angle Φ_z. It can be shown that the following equations hold:

$$\Phi_r = \pi\sqrt{\frac{H(r_0)}{H(r_0) + r_0H'(r_0)}},\ \Phi_z = \pi\sqrt{\frac{H(r_0)}{-r_0H'(r_0)}};$$

consequently

$$\frac{1}{\Phi_r^2} + \frac{1}{\Phi_z^2} = \frac{1}{\pi^2}.$$

It follows immediately that the focusing angles are equal

$$\Phi_r = \Phi_z = \pi\sqrt{2}$$

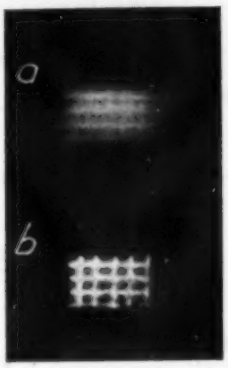
when

$$H(r_0) = -2r_0H'(r_0).$$

This fact can also be expressed by stating that the strength of the magnetic field in the vicinity of $r = r_0$ decreases with increasing r as $1/\sqrt{r}$. That the focusing angles are equal implies that particles starting from the point P on the central line are focused in one and the same point Q situated on the central line at an angular distance $POQ = \pi\sqrt{2} = 255{\cdot}56°$ from P.

The method here proposed for the focusing of β-radiation has been studied experimentally in a spectrograph with a radius of curvature $r_0 = 12{\cdot}5$ cm. For this purpose a magnet has been constructed whereby the electrons are deflected in the ring-shaped, outer pole gap. A similar type of magnet has earlier been used in α-spectroscopy (Cockcroft) to provide a high radius of curvature.

In order to obtain the desired field form, where the field strength in the ring-shaped pole gap varies as $1/\sqrt{r}$ in as large an area as possible, it was found convenient to use semi-empirical methods. If no regard is paid to the inward and outward stray fields the pole profiles should be given a parabolic form. By measuring the inhomogeneity of the field before and after grinding the pole shoes a certain amount, it is possible to compute how the pole profiles should be ground to reduce the influence of the stray fields inside the pole gap. After three grindings, a distance of 26 mm. in the 44 mm. wide pole gap was obtained, which possessed accurately the required form of field.



The double focusing property of the spectrograph was studied in the following way. A wire net was activated with thorium B and placed in the spectrograph. The current through the magnet was adjusted for focusing of the *F*-line ($H\rho = 1383{\cdot}8$) which is dominant in this β-spectrum. Before the slit of the Geiger–Müller tube of the spectrograph, which was situated 256° from the wire net, a photographic plate was placed. The result of an exposure is shown in the reproduction where (*a*) is the image of the wire net in the spectrograph and (*b*) is a contact photograph of the same net for comparison. Besides the vertical meshes, the horizontal meshes are quite well reproduced. These would, of course, not have appeared if a semicircular method had been employed.

In view of the great possibilities of this focusing system, a larger apparatus has been planned. The radius of curvature will be 50 cm. and the employable solid angle will be more than 0·1. The weight of the iron will not exceed 2 tons.

KAI SIEGBAHN
NILS SVARTHOLM

Nobel Institute for Physics,
Stockholm.
May 16.

[1] Svartholm, N., and Siegbahn, K., *Ark. f. Mat. Astr. Fysik*, in the press.

An Attempt to Formulate a Divergence-free Quantum Mechanics of Fields

I HAVE attempted to introduce in a certain way a constant a of dimension length in order to formulate a divergence-free theory of interaction. The functions of field ψ,ψ^* are treated not as Fourier series:

$$\psi = \sum_k \psi_k, \text{ where } \psi_k = A_k e^{i\vec{k}\vec{x}} + B_k e^{-i\vec{k}\vec{x}}, \quad (1)$$

(we have taken as an example the scalar meson field) but as matrices: $\psi = \|\psi_{kl}\|$, where

$$\psi_{kl} = \frac{1}{\sqrt{2}}\left\{(A_l{}^j e^{i\vec{k}\vec{x}} + B_k{}^j e^{-i\vec{k}\vec{x}}) + i\,(A_l{}^k e^{i\vec{l}\vec{x}} + B_l{}^k e^{-i\vec{l}\vec{x}})\right\}. \quad (2)$$

The unsymmetrical part in the first (or second) brackets could as well be used as ψ_{kl}; we have taken both (with the factor $1/\sqrt{2}$) on account of symmetry.

Densities of energy, charge, etc., which are always quadratic in field variables ψ,ψ^* are defined as traces of corresponding matrices, for example:

$$\psi^*\psi = Tr\,\|\psi^*\psi\| = \sum_{kl}\psi^*_{kl}\psi_{lk}. \quad (3)$$

In analogy with the usual commutation relation:

$$[\psi^*(x',t'),\ \psi(x,t)] = \tfrac{\hbar}{i}D(x'-x,t'-t), \quad (4)$$

we assume:

$$Tr[\psi^*(x',t'),\ \psi(x,t)] = \tfrac{\hbar}{i}D(x'-x,t'-t). \quad (5)$$

While in the usual theory the relation (4) fully determined the Fourier coefficients A_k, B_k, A_k^*, B_k^*, we have in our case a certain freedom in choosing the coefficients $A_k{}^l, B_k{}^l \ldots$ (5) may be satisfied by putting:

$$A_k{}^l = A_k e^{-a^2|\vec{k}-\vec{l}|^2}, \quad (6)$$

where A_k means the well-known matrix of the usual theory, $\vec{k},\vec{l}$ are four-vectors and a is a constant. It is possible that a is the well-known 'universal length'. We see at once that the diagonal elements ψ_k are identical with the usual Fourier elements ψ_k and that the modified theory becomes identical with the usual one for $a \to 0$. Instead of $e^{-a^2|\vec{k}-\vec{l}|}$ we might have put another function of argument $(\vec{k}-\vec{l})^2$, which is unity for $\vec{k}=\vec{l}$ and tends to zero for high values of $|(\vec{k}-\vec{l})^2|$.

New expressions for densities of energy, charge, etc., result from this procedure. While in the usual theory it was:

$$\psi^*\psi = \sum_{kl}\psi_k{}^*\psi_l, \quad (7)$$

in the modified theory it is

$$\psi^*\psi = Tr\,\psi^*\psi = \sum_{kl} e^{-a^2|(\vec{k}-\vec{l})^2|}\,\psi_k{}^*\psi_l. \quad (8)$$

This modification does not influence the integral values of the respective observables in the case of a field *in vacuo*: charge remains the integral multiple of the elementary charge, energy the integral multiple of $ch\sqrt{u^2+k^2}$, etc. But it is otherwise with the expression for interaction energy between two fields: our modification changes this expression by causing a relativistically invariant damping of interaction. In case of interaction between electronic and electromagnetic fields we keep the usual formula

$$\mathbf{H}_{(i)} = -\frac{1}{c}\sum_\mu s_\mu\Phi_\mu, \quad (9)$$

but define, of course, s_μ and φ_μ as traces of corresponding matrices. Thus we get for the matrix element H_{kl} describing the probability for transition from state l to k:

$$H_{kl} = e^{-2a|(\vec{k}-\vec{l})^2|}\,H'_{kl},$$

where H'_{kl} means the matrix element of the usual theory. Higher degrees of perturbation calculus yield finite results; in particular, the self-energy of an electron in an electromagnetic field becomes finite. If we assume $a = 1/137\,\mu$ the electromagnetic self-energy is about 20 per cent of the total energy of electron.

In case of fields without negative energy states $\vec{k}-\vec{l}$ is a space four-vector. Then our modification is equivalent to the introduction of an operator $e^{a^2\Box}$ to modify the definitions of densities:

$$s_\mu = e^{a^2\Box}\,s'_\mu, \quad (10)$$

where s'_μ is the density of current in the usual theory. s_μ is a four-vector satisfying the equation of continuity, since $e^{a^2\Box}$ is a scalar operator which commutes with Div. Of course, the operator $e^{a^2\Box}$ is not unique. Prof. Rubinowicz directed my attention to another, namely, $e^{-a^4\Box^2}$, which yields the damping factor $e^{-a^4(\vec{k}-\vec{l})^4}$ and seems better than the former. Both are in some way connected with the Gaussian error function describing the probability of finding the value k in the case when the mean value has been l (or vice versa) and the uncertainty $\Delta k = 1/a$.

GEORG RAYSKI

Institute of Theoretical Mechanics,
University, Warsaw.
May 4.

Hole Theory of the Liquid State

A QUASI-CHEMICAL theory of the liquid state can be built up by incorporating the cluster idea of the Band–Frenkel theory of condensing systems into the Eyring theory; thus the free volume of the liquid molecules will become an adjustable parameter and a function of temperature. A similar theory had already been advanced by Fürth[1], who considered the liquid as a continuum permeated by holes, and attributed the properties of the liquid as due to their presence. Recently, Auluck and Kothari[2] have shown that the energy-levels are discrete on solving the appropriate Schrödinger equation for the hole by BWK method. However, we believe that a classical approximation may be still valid if the temperature of the liquid is sufficiently high above the melting point.

The 'negative' clusters so formed possess physical significance. Their real existence should be interpreted in the dynamical sense of the word; that is, a balance between association and dissociation of them will be reached when the liquid is in the equilibrium state. At any temperature, there is a set of numbers defining the statistical-mean-numbers of clusters of various size, and at the critical point the assembly may be pictured as a liquid permeated by 'negative' clusters, or as a vapour composed of 'positive' clusters alike in equal numbers and sizes. This assumption appears quite permissible, as evidenced by the diffused pattern given by X-ray diffraction in a liquid. These

numbers can be calculated in terms of the density and surface tension of the liquid. Thus many of the results obtained by Band and his collaborators[3] may be immediately recast in the present dissociation treatment.

TSE-PEI TSENG

Physics Department,
Yenching University in Chengtu,
Chengtu, China. May 8.

[1] Fürth, *Proc. Camb. Phil. Soc.*, **37**, 252 (1941).
[2] Auluck and Kothari, *Proc. Camb. Phil. Soc.*, **41**, 181 (1945).
[3] Ch'eng, Tseng, Feng and Band, *J. Chem. Phys.*, **9**, 123 (1941).

Unitary Theory of Hydrocarbon Catalytic Reactions

In the course of the investigation of the catalytic isomerization of butene-1 to butene-2, we have been led to a formulation of such diverse hydrocarbon reactions as the double-bond migration, alkylation, polymerization, and cracking in terms of one mechanism. The experimental facts on which this view is based are as follows.

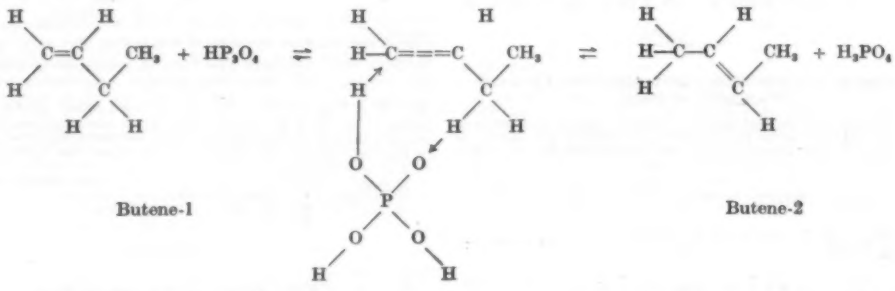
The isomerization of butene-1 was studied using phosphoric acid. The rate was found to be proportional to the pressure of the butene and to the amount of phosphoric acid. The activation energy decreased with increasing phosphorus pentoxide content from 16 kcal. for 70 per cent P_2O_5 to 7·8 kcal. for 97 per cent P_2O_5.

The change of radioactive tritium from radioactive phosphoric acid to butene-1 was studied at the same time. Whereas the activation energy for the isomerization reaction for this concentration of acid was 14·5 kcal., that for the exchange reaction was 17·8 kcal. The rate of exchange at 27° C. was slower than the rate of isomerization, the difference corresponding to a difference in activation energies of 3 kcal. This is in good agreement with the difference obtained from the temperature coefficient of the two processes. Thus, these two processes seem to follow the same mechanism, the difference in the rate being due to the difference in the zero point energies of hydrogen and tritium bonds.

Furthermore, it was found that radioactive water T_2O, and radioactive hydrochloric acid TCl, did not exchange with butene. On the other hand, tritium phosphoric acid did *not* exchange with ethylene but did exchange with propylene.

These experimental findings suggest that the catalytic isomerization of the double bond in the butenes is not due to the addition of a proton to the double bond with formation of a carbonium ion, but must involve another mechanism. We wish to propose the following 'hydrogen transfer' mechanism, which is consistent with the above experimental results and which is based on spacial inter-relationships of catalyst and substrate.

When a phosphoric acid molecule approaches a butene-1 molecule, the approach is postulated to take place in such a way that one of the hydrogen atoms of the phosphoric acid approaches the end carbon atom, while the oxygen having no hydrogen on it approaches the hydrogen atom on the third carbon atom in the butene-1 molecule. It is found by molecular models that there will be a good fit between the phosphoric acid and the butene. When the phosphoric acid breaks away from this complex, it may take with it the hydrogen atom from the third carbon atom and leave a hydrogen atom on the first carbon atom. The result is butene-2.



Butene-1 Butene-2

The critical demand on the catalyst is that it be able to furnish a hydrogen atom and accept a hydrogen atom at a distance of approximately 3·5 A. This condition is satisfied by

Sulphuric acid	3·45
Phosphoric acid	3·46
Silicic acid	3·50
Perchloric acid	3·41
Wet $AlCl_3$ ($HAlCl_4$)	3·46
Partially hydrogenated nickel	3·52

Polymerization of hydrocarbons is visualized according to this mechanism as the hydrogen transfer between two olefins. Alkylation is formulated as a hydrogen transfer from a paraffin to an olefin. Finally, cracking is formulated as the reverse of alkylation. The carbon-carbon bond is broken as the catalyst (alumino-silicic acid) removes the hydrogen from one carbon and transfers it to a carbon atom one removed from the first.

JOHN TURKEVICH
ROBERT K. SMITH

Frick Chemical Laboratory,
Princeton University.
May 16.

Mechanism of the Combustion of Graphite

The following experiments provide a new understanding of the so-called 'surface oxides' to which the essential role in the mechanism of the oxidation of carbon has long been attributed[1].

The experiments were carried out with very finely powdered Acheson graphite of ash content 0·24 per cent (SiO_2, Al_2O_3, Fe_2O_3, CaO and traces of Ti, V, Mg, Co, Cu). The sample was degassed *in vacuo* at 900° C. and kept over sulphuric acid *in vacuo*. The speed of combustion is measured by the removal and estimation of the reaction products, carbon monoxide and dioxide, formed during 15 minutes at 510° C. This speed is expressed conventionally by the mass of carbon gasified during the sampling.

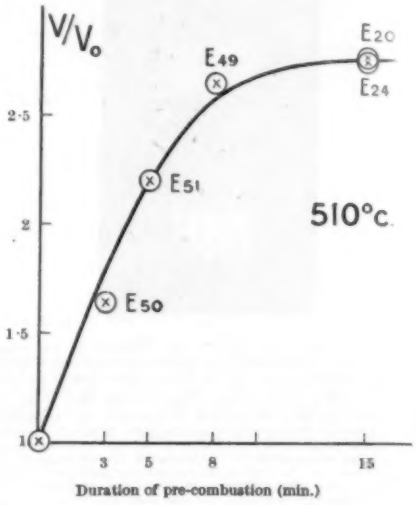


Fig. 1. Time in nitrogen, 1 hr.

The method permits the measurement of a speed V_o which is reasonably reproducible ($V_o = 2·35 \pm 0·15$ mgm./min.), and which does not vary with the duration of combustion. As one might expect, the speed remains the same if, before the run, the graphite sample is kept in nitrogen for one or two hours at the temperature of the experiment.

But the effect is quite different if, before keeping it in nitrogen, the graphite is burned in a current of air, even for only a few minutes (pre-combustion). The curves show the ratio V/V_o (V being the speed of combustion after treatment) either as a function of the duration of pre-combustion (for one hour of immediately subsequent treatment in nitrogen; see Fig. 1) or as a function of the length of stay in nitrogen (for 15 minutes of pre-combustion; see full curve in Fig. 2). It is clear that the contact of hot graphite and oxygen can cause an important stepping-up of the combustibility of graphite if the 'surface oxide' which forms has time to develop protected from the air.

After 'maturing' in nitrogen, not only does the graphite burn more quickly but it also burns more completely; for example, 8–10 per cent of carbon monoxide in the mixture carbon monoxide and dioxide in experiments *E* 20, *E* 24, *E* 33, instead of 23·5 per cent for the experiments performed on non-treated graphite. This state of high combustibility is destroyed little by little during the combustion. Sampling after the 'activated' graphite has burned continuously for 30 minutes shows that the speed of combustion is only 82 per cent of that at the commencement (experiments *E* 56, *E* 21, *E* 25, *E* 34; dotted curve in Fig. 2).

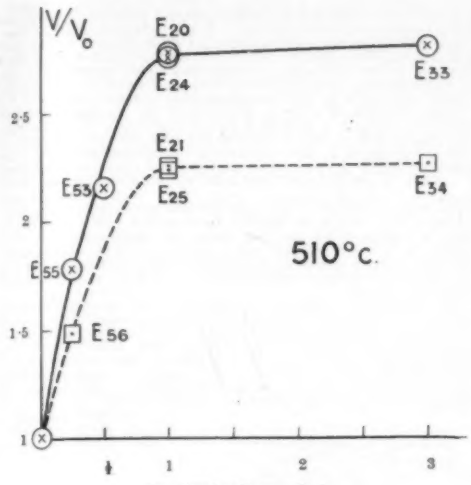


Fig. 2. PRE-COMBUSTION, 15 MIN.

It cannot be that nitrogen has a chemical role because 'maturing' *in vacuo* at the same temperature gives the same results. The effect is the same, qualitatively at least, if nitrogen is replaced by pure carbon dioxide or carbon monoxide.

These experiments provide a first explanation of the phenomenon observed by us in which 'static' combustion or combustion in a weak flow of air (2 litres per hour at the same temperature) causes an increase, sometimes a considerable increase, of the speed of combustion of graphite.

We are greatly indebted to Dr. D. P. Riley, scientific adviser to the British Council in Paris, for translating this note.

M. LETORT
J. MARTIN

Laboratoire de Chimie Minérale,
Faculté des Sciences,
Nancy.

[1] Armstrong, *J. Chem. Soc. Ind.*, **24**, 478 (1905). Rhead and Wheeler, *J. Chem. Soc.*, **28**, 846 (1912); **29**, 461 (1913).

Analysis of Cable Sheathing Alloys

THE analysis of the lead alloys with antimony and tin has been the subject of much study mainly directed to the development of a satisfactory and rapid method for the solution of the metal. The methods commonly adopted involve the use of hydrochloric acid containing bromine, hot concentrated sulphuric acid, or hot mixed perchloric and phosphoric acids. All give satisfactory results, but all have drawbacks either by reason of the time consumed or by the precautions necessary to prevent the loss of volatile halides and the necessity of varying the composition of the reagent to suit antimony alloys.

A great deal of work has been done in these laboratories on the analysis of lead alloy cable sheathing containing up to 2 per cent tin, 0·8 per cent antimony and 0·25 per cent cadmium, and a method which has given us satisfaction has now been worked out. The reagent employed for the dissolution of the metal is based on one of the etching solutions commonly employed to disclose lead structure, and consists of a mixture of 20 c.c. 30 per cent hydrogen peroxide and 5 c.c. glacial acetic acid. This mixture is capable of disintegrating 2·5 gm. of lead alloy, which can be in lump form, in a few minutes. The product of reaction is a mixture of lead acetate, hydroxide and higher oxidation products. Antimony, if present, is not attacked, and the finely divided metal gives the suspension a grey colour. Addition of hydrochloric acid to the mixture decomposes the majority of the hydrogen peroxide, dissolves any antimony, and converts the other metals into chlorides. From this point, the analysis of the solution follows conventional methods, except that it is necessary, when reducing antimony by sulphur dioxide, to heat the mixture on the boiling water bath for ten minutes before boiling off the excess sulphur dioxide. This is essential to remove the last traces of peroxides, which react slowly with reduced antimony and give erroneously low results for this metal.

Tin may be determined in the same solution by the excellent method described by Evans[1].

The method fails for alloys rich in tin such as solders, which are only slowly attacked by the reagent.

G. M. HAMILTON

Research Department,
British Insulated Callender's Cables, Ltd.,
38 Wood Lane, London, W.12.
May 20.

[1] *Analyst*, **56**, 171 (1931).

Internal Photo-electric Effect and Band Spectra in Proteins

THE failure to explain biological reactions by chemical formulæ and correlate biological activity to chemical structure indicates that our basic conception of the structure of living matter, expressed in these chemical formulæ, is incorrect. This conception may be summed up by saying that molecules are built of atoms, atoms of electrons and nuclei, each nucleus having its electrons and each electron belonging to a nucleus, only valency or π electrons being shared by two or more nuclei.

It has already been pointed out[1] that many biological phenomena could be explained by supposing that outer electrons of the protein particle form one common system, belonging to the whole particle, in analogy with the modern theory of solids in which the electrons belong to the whole system and cannot be correlated to single atoms. Evidence of such protein structure was found lately in my laboratory by J. Boros, who showed that the electric conductivity of coloured protein films could be increased several hundred per cent by illumination. A large number of dyestuffs was found to be active.

This observation can be explained by supposing that electrons of the protein form a system belonging to the whole particle, the energy terms of the single electrons having fused to bands. The electrons of the dye, excited by irradiation, move on common incompletely filled energy bands of the protein. The observed photo-electric effect also shows that the common band extends over a great number of particles and is not limited to single micels. It is not impossible that in living systems such continua are limited by the cell-wall. It is hoped that the effect described will make biological phenomena accessible to quantum-mechanical treatment.

Prof. P. Gombás and K. Laki took an active part in the development of this research.

A. SZENT-GYÖRGYI

Institute of Biochemistry,
University of Budapest.
May 14.

[1] *Science*, **93**, 609 (1941).

Nucleic Acid and the Beginning of Meiosis

A NEW acetic-lacmoid squash method of preparation followed by Feulgen staining of the desoxyribose nucleic acid[1] has made it possible to trace certain chemical and physical changes undergone by the nucleus during the critical stages at the beginning of meiosis. The most favourable material is found in some liliaceous plants with large nuclei. Both types of mother-cell are shown up from their neighbours by their higher concentration in the cytoplasm of nucleic acid which, experience has shown, is associated with deeper lacmoid staining. The embryo-sac is to be preferred to the pollen mother-cell, however, since its development, although similar, is slower and the cell itself, being large and solitary, is more easily picked out from the surrounding somatic cells.

The following species of the genus *Fritillaria* were examined[2]:

With heterochromatin		Without heterochromatin	
2*x*	*F. lanceolata*	2*x*	*F. drenowskii*
	F. libanotica		*F. Elwesii*
			F. Meleagris
			F. nigra
			F. obliqua
			F. sichiana
			F. thunbergii
3*x*	*F. lanceolata*		

The pre-meiotic telophase is normal. Heterochromatin when present remains charged with nucleic acid. The opening of the meiotic prophase is, on the other hand, marked by changes of a special kind which fall into three stages (of which we hope to publish photographs later):

In the first stage the thread structure of the chromosomes is still invisible. But, distributed throughout the nucleus, are masses of Feulgen-positive material of fairly uniform size. They are not rounded, like the semi-fluid heterochromatin, but angular or fibrous in outline. They show no connexion with the nucleolus or, in species possessing it, with the heterochromatin. Indeed, their uniform size and distribution suggest no connexion with chromosome elements at all.

The second stage reveals a shrinkage of these nucleic acid aggregations. At the same time the chromosomes are becoming visible and they appear as even unbeaded threads, that is without chromomeres. Indeed, they have the form that chromosomes take at the very beginning of an ordinary mitosis except that they are, of course, single. It seems that the nucleic acid is now being transferred from the aggregations to the chromosomes (or at least to their euchromatic parts), which have thereby become stainable. The aggregations are merely temporary dumps.

The third stage corresponds (so far as nucleic acid charge is concerned) with that described as leptotene in animals. The dumps have disappeared. The chromosomes are more heavily charged and along their threads chromomeres are now distinguishable owing, it seems, to the intermittent stretching of the threads. Finally, pairing has already begun. It has been suggested on the evidence of the later stages that charging and pairing begin near the centromeres of the chromosomes in *Fritillaria*[3] but in these early stages the centromere is not yet distinguishable from the other chromomeres.

During these changes such deposits of nucleic acid as there may be on the heterochromatin are undiminished. Its rounded outlines are undisturbed. This persistence suggests that the temporary dumps contain nucleic acid in a different form from that attached to the heterochromatin. The dumps are more accessible.

Desoxyribose nucleic acid is characteristically found only in association with the chromosome thread[4]. Bodies containing it have been seen in the nucleus unassociated with the chromosomes only as a result of separation from them. This situation has been established by Feulgen staining in mature neutrophil myelocytes in the mouse[5], at first anaphase of meiosis in the oocytes of butterflies[6] and during the growth of the oocytes of the toad[7]. In all these cases the separation

is part of a process of excretion into the cytoplasm where it is evidently disintegrated and perhaps converted into the ribose form. Extrusion seems to be due to a breakdown, through overloading, of the normal conversion and transfer of nucleic acid from the heterochromatin of the nucleus to the cytoplasm. The nucleic acid appears as drops in which there is probably an admixture of the ribose form which Brachet[9] finds in heterochromatin. Some admixture in the excretion drops and in the heterochromatin is no doubt responsible, at once, for the rounded outline, such as the highly polymerized desoxyribose form alone does not normally assume, and for the lower availability.

Our temporary pre-prophase dumps are something quite different from the excretion drops. They seem to represent a third type of aggregation of desoxyribose nucleic acid in the nucleus, in addition to those found associated with the euchromatin and the heterochromatin, a type giving maximum availability. It may be that this availability depends on the absence of admixture. Their condition and function are unique, on this view, in consisting of desoxyribose nucleic acid, free and relatively pure, which is going to the chromosomes and not coming from them.

In tracing this development it seems that we can detect certain necessary steps of cause and effect. The transfer of nucleic acid to the undivided chromosomes is followed by the formation of specific chromomeres of different sizes at different distances apart. This change in turn is followed by the pairing of the corresponding chromomeres in homologous chromosomes. The series of changes which will lead to crossing-over, segregation and the whole course of meiosis is thus fully initiated. What sets the series of changes in motion seems to be the premature priming of the chromosomes with nucleic acid (premature with respect to their reproduction).

The reproduction of the chromosomes is connected, no doubt, with the protein-formation of the chromomeres, and in this regard it will be seen that our observations agree very well with the view of Caspersson[8] that the chromomeres are formed owing to the stretching of the fibre between genes by the accumulating proteins produced by the genes themselves. On this view the chromomere represents both a physiological and a mechanical unit. So far as the prophase of meiosis is concerned, it is the effective unit. Mechanically this is all that matters, but physiologically, of course, the effective unit or gene need not be the same in all the cells of an organism[10].

These observations thus throw light on the two complementary aspects of the beginning of meiosis, and of mitosis as well, those concerned with the nucleic acids and with the proteins. It must be our concern to translate the movements and activities of chromosomes into terms of these two components.

C. D. Darlington
L. F. La Cour

John Innes Horticultural Institution,
London, S.W.19.
June 14.

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Spectrophotometric Assay of Vitamin A and the Conversion Factor

We have undertaken a new determination of the 'conversion factor' relating the extinction factor to the biological activity of vitamin A. For the spectrophotometric and biological investigations, vitamin A concentrates of widely varying activity as well as crude liver oils were used. They were first submitted to purification according to the chromatographic method described by one of us[1]. The adsorbing material used consists of different layers of aluminium oxide, the activities of which had been accurately standardized[2]. We came to the following conclusions.

When comparing the activity of the international vitamin A standard (β-carotene) and of vitamin A preparations on rats, it was found that the growth produced by β-carotene or by equivalent quantities of vitamin A is subject to great variations, depending on: (*a*) the diet used, (*b*) the amount of carotene or vitamin A administered per dose, (*c*) the test animals, (*d*) the season of the year. The growth obtained is not proportional to the amount of vitamin A fed. Small doses produce a considerably stronger growth (calculated per unit of vitamin A fed) than the larger doses. To obtain reproducible results, comparable to those obtained with β-carotene, under the conditions prevailing in our laboratories, the best daily dose was found to be 4–5·6 I.U. Under the conditions of the Laboratory for Vitamin Control of the Institute for Physiological Chemistry of the University of Basle, the most suitable daily dose lay between 2 and 3 I.U. These conditions are largely dependent on the food and the quantity of oil given with the vitamin A (or β-carotene). By adapting our food conditions, etc., to those of the Laboratory for Vitamin Control at Basle, similar results were obtained at both places. We have to thank Prof. S. Edlbacher, head of the Institute for Physiological Chemistry, for his figures.

Observing the best conditions mentioned above, we obtained for the preparations we tested a conversion factor of 1,691. From the results of the Basle Institute for Physiological Chemistry a conversion factor of 1,712 was calculated. The mean value is thus approximately 1,700. In tests carried out without observing the precautions described, conversion factors between 1,000 for high daily doses and 3,600 for low daily doses of vitamin A were obtained. The above-mentioned average factor of about 1,700 was found with concentrates and liver oils of widely varying vitamin A activity, provided the vitamin A preparations had been submitted to chromatographic purification before the spectrophotometric determination. When, however, samples were tested without previous chromatographic purification, very low conversion factors were obtained (below 1,000, some even so low as 400–600). This was due to the presence of impurities which interfere with the spectrophotometric determination of vitamin A and which are quantitatively eliminated by the chromatographic method described[1].

Within the limit of error, no difference in the conversion factor of vitamin A-ester and of vitamin A-alcohol was found. Thus biological equivalence between vitamin A-esters and vitamin A-alcohol exists.

Since vitamin A is now available in crystallized and fully characterized form, it is to be hoped that the old international standard of vitamin A (crystallized β-carotene) will soon be replaced by an equally well-defined vitamin A preparation. Such a standard substance would be absorbed and utilized better by the test animals than β-carotene and would be therefore preferable for the comparative assay of vitamin A by biological tests. In addition to crystallized vitamin A, a highly purified and accurate working standard could easily be prepared in practically unlimited amounts from appropriate concentrates (molecular distillates) by the use of the chromatographic method described.

The suggestion of Metcalf to compare the spectrophotometric extinctions of unknown materials with that of crystallized vitamin A eliminates for general work the complications mentioned above. The physico-chemical method of determination will, however, not completely dispose of the biological evaluations. For special problems it will now and again be necessary to ascertain whether the quantity of vitamin A determined by the physical method actually corresponds biologically to analogous quantities of pure vitamin A.

Paul Müller
Marc Reinert

Analytical Laboratory and
Pharmacological Laboratory,
F. Hoffmann-La Roche, Ltd.,
Basle.

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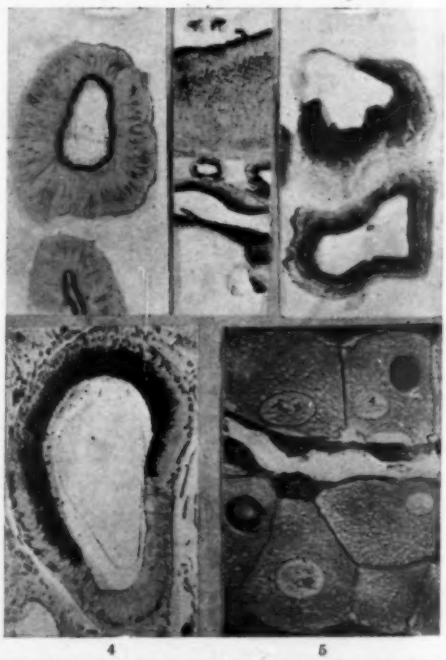
Alkaline Phosphatase in Invertebrate Sites of Protein Secretion

Two familiar invertebrates, the caterpillar of the goat-moth (*Cossus cossus*) and of a common spider (*Tegenaria domestica*), have been investigated for alkaline phosphomonoesterase activity by the cytochemical technique of Takamatsu[1] and of Gomori[2,3].

In goat-moth caterpillars, a strong positive phosphatase reaction is given by the silk glands (Fig. 1) and also by the mid-gut (Fig. 2) and



Photomicrographs with alkaline phosphatase deep black. Figs. 1–3: Caterpillar (*Cossus cossus*). 1, Trans. section of silk gland (× 54). 2, Long. section of wall of mid-gut (× 57). 3, Trans. section of Malpighian tubes (× 120), also seen in 2. Figs. 4–5: Spider (*Tegenaria domestica*): 4, Long. section of silk gland (× 73). 5, Long. section of ovary (× 90).

Malpighian tubes (Fig. 3); in each of these organs the enzyme is localized in a narrow band at the inner margin of the cells. In the Malpighian tubes the restriction of phosphatase to the brush border is particularly evident where the latter does not extend completely round the inner side of the tube (Fig. 3). The enzyme distribution in the mid-gut and Malpighian tubes recalls that in vertebrate small intestine and proximal convoluted kidney tubule respectively. In the long, thin, uncoiled silk glands, which run the length of the body and open near the mouth, only the lower, or anterior, two thirds of the gland, together with the duct, show the enzyme border. In the phosphatase-containing regions of the gland, at least two processes occur: (*a*) the nature of the secretion from higher regions is altered and (*b*) a secretion different from that formed higher up the gland is produced.

The spider also showed three main sites of phosphatase activity, the silk glands (Fig. 4), the Malpighian tubes and the ovary (Fig. 5). In the maturing ovary there are several ramifying tubes and each egg is connected to one of these by a short stalk of small, closely packed cells, with prominent nuclei. Alkaline phosphatase is strongly localized around the outer borders of these cells, to which the thick outer egg membrane is attached in a manner suggesting that it may be secreted by the stalk (Fig. 5). In the Malpighian tubes the enzyme is, as before, restricted to the inner margins of the cells. The much convoluted silk glands, of several kinds, all have walls consisting of a single layer of tall, narrow cells, each with a small distinct basal nucleus and a mass of secretion droplets filling the rest of the cell. Phosphatase is restricted to the nuclei and the inner margins of the cells, where the black deposit indicating its presence is actually on the secretion droplets. The precise association may be an artefact, but it is reminiscent of the adenosinetriphosphatase activity associated with myosin. Particularly in the aciniform glands there are small areas devoid of the enzyme activity (Fig. 4), a condition comparable with Millot's[4] division of the glands into two differently staining regions.

Thus, while the silk glands of both animals have some regions devoid of the phosphatase border, it is nevertheless difficult to believe that this enzyme is not concerned at some stage in the elaboration of the finished product. Such simultaneous occurrence of alkaline phosphatase and fibrous protein production has previously been recorded in healing wounds[5], bone[6], hair follicles[7], teeth[8], and capillaries. It is also known that in the healing wounds of vitamin C-deficient guinea pigs, phosphatase activity as well as collagen production is lower than in normal wounds[9].

The evidence available at present, therefore, indicates that alkaline phosphatase is concerned in the production of many fibrous proteins. It has in fact been suggested that protein synthesis involves more than mere reversal of proteolytic activity, and there are many indications that nucleic acids participate in the process[10]. But at what point phosphatase may function in the overall picture, including both synthesis and subsequent secretion, cannot be decided at present.

J. R. G. Bradfield

Department of Zoology,
University of Cambridge.
May 18.

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Symbiosis Between Myxobacteria and Nitrifying Bacteria

In studying the biology of myxobacteria I have arrived at the conclusion that this group of micro-organisms is much more widely spread in Nature than it is commonly considered. The morphology and systematics of myxobacteria are little known to the wider circle of microbiologists, and their role in the circulation of substances in Nature has not been sufficiently studied. In 1933 I discovered cellulose-decomposing myxobacteria of the genus *Sorangium*, and it was later established that the chief agents of cellulose decomposition under aerobic conditions belong to the family Myxococcaceæ or Sorangiaceæ. This circumstance induced me to turn my attention to different micro-organisms already described in the special literature as causative agents of various transformations of carbon and nitrogen and showing some similarity to myxobacteria in their structure and history of development. The new nitrifying bacteria, discovered in soil by Romell and later by Winogradsky and Winogradskaia and described by them under the name of *Nitrosocystis*, presented particular interest in this respect. The description of these organisms and the photographs accompanying the report seemed to indicate that these authors mentioned were evidently dealing with myxobacteria.

To obtain cultures of *Nitrosocystis* I inoculated silica gel plates, impregnated with the mineral medium of Winogradsky and covered with a layer of chalk, with particles of soil. 3–4 weeks later, zones of chalk dissolution appeared around the soil particles, and gel fragments began to give a sharply positive nitrite reaction. With the help of the microscope we discovered in these zones of nitrification round fruiting bodies, myxobacteriæ of the genus *Sorangium*. The fruiting bodies reached the size of 30–40 μ and were composed of smaller polygonal cysts. These smaller cysts could be easily crushed between object- and cover-glass, and in this manner one could see that they consisted of small short rods with rounded ends. Transfers were made from the zones of nitrification to a solid medium consisting of potato-broth, peptone and agar. Colonies of *Sorangium* developed on this medium, and in these later on there appeared fruiting bodies identical with those which had been observed in the zones of nitrification. A one-cell culture was obtained and studied and its history of development was the one usually observed in myxobacteria of the genus *Sorangium*. Young vegetative cells have the shape of rods, which later become shorter and thicker. Accumulations of these shortened rods form the smaller cysts, out of which the fruiting-bodies mentioned above are formed in their turn.

The isolated cultures are heterotrophic. They develop readily in the usual nitrient media and lack absolutely the ability to oxidize ammonia, that is, to nitrify. The question naturally arises, how are we to explain the ability of these myxobacteria to develop on silica-gel plates, that is, on the elective medium for nitrifying microbes? The answer to this question is given by microscopic observations on the youngest zones of nitrification. Before any denuded gel areas make their appearance on the surface of the plate, isolated cells of the classical chemotrophic micro-organism, the *Nitrosomonas*, can be detected in the chalk covering this surface. Later on, the spherical cells of *Nitrosomonas* are incorporated by the accumulations of *Sorangium* cells. It follows from this that the development of the nitrifying bacteria precedes that of the myxobacteria. The first, being typical chemotrophs, synthetize the organic substance which is evidently utilized for their nutrition by the second after the autolysis of the *Nitrosomonas* cells. The mutual relations between the two species of micro-organisms seem to be possibly symbiotic, since the accumulations of mucous zoogleæ of the myxobacteriæ retain the moisture necessary for the growth of *Nitrosomonas* and may also protect the latter from external unfavourable influences. Desiring to emphasize this particular character of the bacterium I gave it the name of *Sorangium symbioticum*.

The possibility is not to be disregarded that micro-organisms, described as new species of nitrifying bacteria, are really an association of chemotrophic and heterotrophic micro-organisms.

A. Imsenecki

Microbiological Institute,
Academy of Sciences,
Moscow.
May 11.

Preliminary Survey of the West African Rain-Forest Canopy

Making use, with only slight modifications, of the methods elaborated by Dr. Hingston and the staff of the University of Oxford expedition to British Guiana, we were able during the summer of 1945 to make a preliminary survey of the canopy of the rain-forest of the "Réserve forestière du Banco" near Abidjan (Ivory Coast). We built, at 150 ft. from the ground, an observation platform from which we could collect continuously in the foliage of the canopy, either directly or with light-traps. On this platform we passed numerous days and a number of whole nights.

From this platform, and from lower stations, we got complete temperature and humidity records for a number of weeks, which will be published elsewhere. The collection of animals, mostly insects, made in the canopy is being intensively studied by the various specialists concerned. But it is already possible to give a picture of the fauna of the canopy, as contrasted with the fauna of both the lower forest strata and the forest margin or clearings.

Though a number of species, living on or near the ground, and particularly the ants, *Camponotus maculatus* F. and *Œcophylla longinodis* Latr., are found up to 140 ft., the majority of the fauna of the canopy are not found in other strata of the forest: *Gyna*, Tenoderinæ, *Popillia*, many Pseudophyllids are represented by different species or genera in the canopy and under it. Many more, though they may live in the northern savannas, near the ground, are not known in the forest, except from the canopy: such are *Embia*, Mantispids and some Ascalaphids such as *Dicolpus voluceris* Gerst.

An interesting fact results from the presence, in the thick layer of humus upon the principal branches of the canopy (it may be 6–10 cm. deep), of a rich fauna of soil animals: *Collembola*, *Thysanura*, Isopods, Myriapods are numerous. One can trace their path from the ground upwards, in the small pockets of earth lodged around the roots of the epiphytic plants growing along the trunks.

Most of the species of the canopy have the brilliant colours and active flight of the fauna inhabiting the clearings and the forest margins, as opposed to the sombre colouring of the underwood fauna. But the species of these two habitats are usually quite different, specifically and generically.

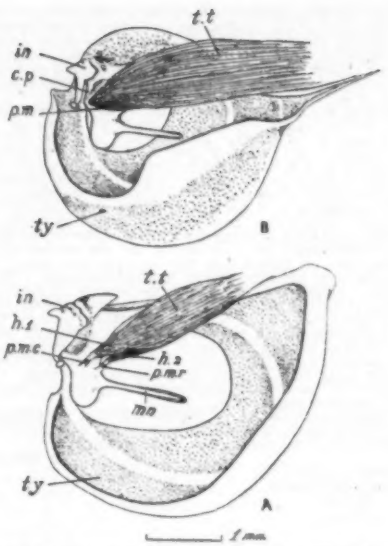
We may conclude that, pending a complete study of our material, the West African canopy is a particular habitat, with a distinct fauna and a special ecological climax. We were not able to define between the ground and the canopy a succession of superposed layers such as Hingston found in Guiana.

Renaud Paulian

Muséum d'Histoire Naturelle,
Paris.

The Processus Muscularis and the Tensor Tympani Muscle of Bats

An 'accessory' processus muscularis, the significance of which has not been disclosed, was described by Doran[1] in the malleus of *Asellia tridens* (Microchiroptera). The process is said to be of very rare occurrence in bats. Dissection of fresh *Asellia tridens*, however, revealed the presence of a two-headed tensor tympani muscle, the short and smaller outer head being inserted to the 'accessory' process, while the long inner head is attached to another process which Doran considers as the homologue of the processus muscularis constantly observed in other insectivorous bats. This remarkable feature of the tensor tympani to which I can find no reference in the literature is not a peculiarity of *Asellia tridens* (Hipposideridæ) alone, but is found in various other species of bats. It occurs in *Taphozous perforatus*, *Lipanycteris nudiventris* and *Rhinopoma microphyllum*



MALLEUS, INCUS AND TENSOR TYMPANI MUSCLE OF *Rhinopoma microphyllum* (*A*) AND OF *Nycteris thebaica* (*B*). INTERNAL VIEW. *c.p.*, cephalic peduncle; *in.*, incus; *ma.*, manubrium; *p.m.*, processus muscularis (*p.m.c.*, its caudal part, and *p.m.r.*, its rostral part, which corresponds to the accessory process); *t.t.*, tensor tympani muscle (*h.*1 and *h.*2 are the long inner and short outer heads respectively); *ty.*, tympanic bone.

(Emballonuridæ), in *Tadarida ægyptiacus* and *T. teniotis* (Molossidæ).

The two heads of the tensor tympani are variously developed in the different species. They are of almost equal size in *Rhinopoma microphyllum* (Fig. *A*); however, the short head is smaller than the long one in *Asellia tridens*, *Tadarida ægyptiacus*, *T. teniotis*, and is much reduced in *Taphozous perforatus* and *Liponycteris nudiventris*. The short head appears to be lacking in *Rhinolophus acrotis* (Rhinolophidæ), *Pipistrellus kuhli*, *Otonycteris hemprechi* and *Scotozous rüppelli* (Vespertilionidæ) as well as in *Rousettus ægyptiacus* (Pteropidæ-Megachiroptera).

Eschweiler (*cit.* Edgeworth[2]) stated that in *Ornithorhynchus* the tensor tympani consists of two parts which are inserted into the malleus.

Among bats the two muscular processes may be connected by a low ridge as in *Tadarida ægyptiacus* and *T. teniotis* or may merge into one another forming a broad and prominent projection as in *Taphozous perforatus* and *Liponycteris nudiventris*. A broad crest-like processus muscularis is found in *Nycteris thebaica* (Nycteridæ), in which species the tensor tympani is inserted along the broad edge of the process (Fig. *B*).

Doran's figures and description of the malleus in the different species of mammals indicate that the processus muscularis, which is generally located at the base of the manubrium, may be found either on the cephalic peduncle (neck), much in front of its usual site, or lower down on the manubrium midway between its base and tip. It can, therefore, be assumed that in the pre-mammals the processus muscularis might have extended between these two extreme points and that the tensor tympani was inserted along its broad edge. The case of *Nycteris thebaica* is an approach towards this state and can be considered as a primary condition from which those found in other bats may be derived.

The different species of bats examined, therefore, present stages in the separation of the tensor tympani muscle into two portions, and in the disappearance of one of these parts, namely, the short outer head with corresponding modifications in the form of the muscular process.

Full details of this study will be published elsewhere.

K. WASSIF

Department of Zoology,
Fouad I University,
Cairo.

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Successful Feeding Experiments with an Adult Trombiculid Mite (Order Acarina)

ALTHOUGH certain species of Trombiculid mites belonging to the sub-family Trombiculinæ have long been suspected of being the carriers of tsutsugamushi disease, now more commonly referred to as scrub typhus, it is only recently that Blake *et al.*[1] have demonstrated the presence of *Rickettsia orientalis* in *Trombicula fletcheri* Womersley and Heaslip. In their paper, which contains a valuable review of the literature on scrub typhus, they say that "existing knowledge regarding the life-history, habits and bionomics of trombiculid mites is quite inadequate in view of their importance as disease vectors and pests of man". This is particularly true of the feeding habits of the nymphal and adult stages. Miyajima and Okumura[2], who first established *Trombicula akamushi* (Brumpt) as the vector of tsutsugamushi fever in Japan, say that "in nature the nymph and adult seem to live on the juice of plants". Womersley and Heaslip[3], too, appear to believe that the adults are probably vegetarian. Banks[4], on the other hand, makes a general statement to the effect that the mature mites feed on small insects, and mentions particularly plant lice, young caterpillars and grasshopper eggs. But he gives no details of any observations on the subject. Blake *et al.* (*loc. cit.*), in summing-up our present knowledge of the feeding habits of the nymphal and adult stages, say that "the food of these stages is variously reported to include plant juices, decaying organic matter and insect excrement". It would appear, therefore, that though adults have occasionally been reared in the laboratory there are few, if any, definite records on their feeding habits. Indeed it would seem doubtful whether they have actually been observed in the act of feeding.

While engaged recently in carrying out observations on the association of *Mansonia* (*Mansonioides*) *uniformis* (Theobald) with a species of the water fern *Salvinia* (possibly *auriculata*), a recently introduced pest which is spreading with great rapidity in and around Colombo, we came across large numbers of a relatively large adult Trombiculid mite. The *Salvinia* has now completely choked up what was formerly a large pond, and mites were found crawling actively about the plants. Examination of the soil on the banks also revealed the mites in numbers larger than we had ever previously experienced in our studies of Trombiculids in Ceylon. The mite displays the figure of eight form so characteristic of the nymphs and adults of this group and is bright red in colour. Several adults have laid eggs in the laboratory and the larvæ that emerged have been found to be identical with larvæ collected previously from the ears of bandicoots (*Bandicota malabarica* (Shaw)) trapped in the vicinity. Some of these larvæ have been bred out to the nymphal stage by a technique already described (Jayewickreme[5]). The mite appears to be identical with *Trombicula acusculelleris*, Walch.

As the adult mite had been found crawling about the leaves of *Salvinia* on some of which were numerous clusters of eggs of *M.* (*M.*) *uniformis*, we decided to test the possibility that the mite may feed on these eggs in Nature. Accordingly, we offered several mites the opportunity of feeding on egg clusters in the laboratory and found that they readily attacked them. Actual imbibition of fluid through the cheliceræ into the gut was observed under the microscope, and complete distension of the abdomen invariably followed a full feed. We later offered the mites the ovaries of a gravid *Mansonia* mosquito which had been dissected out, and found that they fed readily on them too. Afterwards we observed them feeding on the ovaries of *Anopheles subpictus* Grassi and *Anopheles vagus* Donitz. Finally, we decided to offer a batch of about fifty adult mites a gravid *A. subpictus* mosquito, which had just been killed by stunning. The mites immediately clustered round the mosquito and within a couple of hours it had been sucked dry. They have since fed in the same manner on several occasions.

S. H. JAYEWICKREME
W. J. NILES

Division of Medical Entomology,
Colombo.
May 18.

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Action of α-Hydroxyisobutyric Acid on Micro-organisms

IN connexion with a recent letter by Lovelock[1] on the use of organic acids, including α-hydroxyisobutyric acid, as aerial bactericides, some other observations on the properties of the latter acid may be of interest. Its non-assimilability by moulds has already been noted[2], as well as its application to the preparation of buffers which resist the action of moulds[3].

It was also found that in a synthetic culture medium at *p*H 3·8 the acid was not metabolized as the sole source of carbon by eleven species of yeasts and torulæ, although under similar conditions seven of them slowly metabolized commercial *dl*-lactic acid as indicated by growth in the medium and a rise in *p*H. In media of higher *p*H, the acid was possibly assimilated by only one of thirty-seven species and strains of saprophytic bacteria. In a single lot of media, *Alkaligenes fæcalis* appeared to metabolize the acid, but this result could not be reproduced in later lots.

In ordinary culture media where the conditions of *p*H, temperature and nutrition were otherwise favourable, α-hydroxyisobutyric acid (and its homologue α-hydroxy-*n*-butyric acid) in concentrations as high as 128 mgm. per 100 c.c., did not inhibit the growth of the pathogenic bacteria *Erysipelothrix rhusiopathiæ* Lederle No. 358, *Diplococcus pneumoniæ* type I, strain SV, *Streptococcus hemolyticus* strain C203, *Pasteurella multocida* Lederle strain, or *Mycobacterium tuberculosis* var. *hominis* No. 607 of the American Type Culture Collection.

These results indicate that the α-hydroxyisobutyric radical *per se* is physiologically indifferent to most if not all micro-organisms and is not readily metabolized or otherwise broken down. On the other hand, it has no pronounced antibacterial properties. Its activity as employed by Lovelock is probably owing to the production of a strongly acid reaction, since a 0·2 *M* solution of α-hydroxyisobutyric acid has a *p*H of 2·30, while a saturated solution has a *p*H of approximately 1·40 at 25° C. In neutral solutions, the α-hydroxyisobutyric radical is without marked effect on the animal body. The calcium salt (stabilized with borate) is used to some extent in veterinary medicine to remedy calcium deficiency in cattle, under the name of 'calcium borohibate Lederle'.

The practical utility of aerial germicides is of course open to debate, but the indications are that α-hydroxyisobutyric acid may have some applicability to such use because of its ready volatility with dry heat. The acid is likewise somewhat volatile with steam, which might make it useful where a steam inhalation of mildly germicidal vapours is desired. It has the disadvantage of being corrosive to some metals.

WALTER C. TOBIE
GILBERT B. AYRES

American Cyanamid Company,
1937 West Main Street,
Stamford, Connecticut.
April 11.

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Misuse of the Term 'Evolution'

IN the review of my "Essays on Human Evolution" in *Nature* of June 8, p. 749, Prof. A. D. Ritchie raises a matter of high importance to students of human origins—the right use of the word 'evolution'. "Biological evolution in the proper Darwinian sense," he claims, "is the process by which the normal kind of species, of fairly definite and fairly homogeneous genetic character, gives rise to one or more daughter species of different but equally definite and homogeneous genetic character." In giving this definition, Prof. Ritchie has failed to note that Darwin, when he came to write "The Descent of Man", revised his evolutionary terms; in "The Origin of Species" he speaks of competition and selection as taking place between "individuals", "varieties" and "species"[1], but in "The Descent of Man" his "evolutionary units" become "communities", "tribes" and "nations", and it is between such units that the processes of evolution go on, the processes of variation, competition and selection. Over and over again, Darwin emphasizes the fact that primitive man confined his sympathy and aid to members of his own community. The following is the only passage in which he mentions "race" as a competing unit: "Extinction follows chiefly from the competition of tribe with tribe, and race with race"[2]. This must be regarded as a slip of the pen, for elsewhere he recognizes very clearly that competition and struggle for survival are carried on between communities, tribes or nations of the same race. Only when a community of one race is brought into contact with a community of another race does an interracial struggle arise. Thus if I have erred in using the term 'evolution' to describe the processes which change the nature and destiny of a community, a tribe, or a nation, I have erred in very good company.

Prof. Ritchie apparently denies that civilization has any part in human evolution. This is what I suppose him to imply when he writes: "to call changes in human habits, tradition, culture, in what men learn in the course of their lives, evolutionary, is to make clear thinking impossible". Is not industry part of a nation's heritage? And is not industry the parent of military power? Has not military power, as exerted in the recent War, altered the evolutionary destinies of nations? Every event and process which weakens or strengthens a nation I regard as a factor in human evolution. It is not the recognition of this truth which confuses; confusion has arisen from a failure to recognize it.

One other important point remains. Is the whole species of mankind (*Homo sapiens*) now in process of evolution? Prof. Ritchie thinks not, for he has written: "The term evolution in the . . . sense of full transformation of species cannot be applied to anything that is known to have happened to the human race since the earliest agricultural settlements, 200–300 generations ago". I am content with a period much shorter than the 7–8,000 years postulated by Prof. Ritchie. Four or five centuries will suffice for my purpose. Let us take a map of the world, one showing the strength and distribution of human races before Columbus and Capt. Cook sailed the seas, and place alongside of it another which shows the distribution and strength of races as they are in the modern world; the differences between those two maps represent the evolutionary changes which have transformed the whole species of humanity in the course of less than five centuries. Many thousands of evolutionary units have been exterminated; hundreds of new units have been formed. Races which are confined to small areas in the old map have spread into great new regions in the later map; a few peoples have just held their own; numbers are on the downward path. The assemblage of human genes in the modern world is very different from that of five centuries ago. All the factors which have brought about these changes are, in my opinion, factors in human evolution. I hold that evolutionary changes are taking place in the human world of to-day at a more rapid pace than ever before in the long history of mankind.

ARTHUR KEITH

Downe, Kent.
June 10.

[1] "The Origin of Species" (6th Ed., 1885), p. 58.
[2] "The Descent of Man" (Murray's reprint, 1913), p. 282.

A MAN 'inherits' the colour of his eyes from his ancestors; that is a process which has to do with evolution. He may 'inherit' a house from them; that is a different process, which in itself has nothing to do with evolution. Sir Arthur Keith's question, "Is not industry part of a nation's heritage?", and what follows, show that he fails to distinguish between genetic and social changes. I still think this is a mistake, even if 'inherited' from Darwin. In some cases there will be a relation between social and genetic change, but specific evidence as to what it is and where it occurs is needed before it can reasonably be asserted. Sir Arthur Keith, I submit, does not produce such evidence.

A. D. RITCHIE

Tyndall and Stefan's Radiation Law

THE reference to the work of Tyndall asked for by Prof. John Satterly recently[1] is to a paper in *Annalen der Physik*, **134**, 36 (1865), and not in a book by Tyndall. The paper describes experiments on the emission of radiation from a platinum spiral, with an apparatus having a rock salt lens and prism and a thermopile. Tyndall's paper is mentioned by Wüllner[2], who gives the calculation referred to by Prof. Satterly.

J. R. PARTINGTON

50 Maids Causeway, Cambridge.

[1] *Nature*, **157**, 737 (1946).
[2] "Lehrbuch der Experimentalphysik", **2**, 215, 5th edit. (Leipzig, 1896).

IN the published account of the 1865 Rede Lecture, "On Radiation" ("Fragments of Science", 1871), John Tyndall describes an experiment showing that a rise in temperature of an incandescent body augments the invisible radiation along with the visible. He tabulates the energy of the obscure radiation for increasing temperatures of his source, a spiral of platinum wire, and describes the appearance of the spiral, though the actual temperatures were not measured.

The relative energies measured by his thermopile for an intense white appearance and for red were as 440 is to 37, or 11·9 to 1, exactly the figure mentioned by Prof. V. Satterly[1]. Hence it is likely that these experiments gave rise to the legend referred to, though the temperatures associated with red and white heat seem a little low.

Estimating the approximate temperature of Tyndall's wire from the colour scales published in engineering and laboratory handbooks, and converting to absolute scale, his results, when plotted on double logarithmic paper, yield for the eight highest temperatures quite a good straight line of the correct slope. The interpretation of his colours was as follows:

Tyndall	Dull red	Red	Full red	Orange	Bright orange	Yellow	White	Intense white
Estimated temperature	700	850	950	1000	1100	1200	1300	1500° C.
Energy of obscure radiation	25	37	62	89	144	202	276	440

C. N. DAVIES

Industrial Health Research Board,
C/o London School of Hygiene and Tropical Medicine,
London, W.C.1.
June 3.

[1] *Nature*, **157**, 737 (1946).

Scientific and Industrial Research in Great Britain

IN the admirable article on "Scientific and Industrial Research in Great Britain" appearing in *Nature* of June 1, the suggestion is made, concerning the grants made by the Department of Scientific and Industrial Research to promising research workers or as maintenance allowances to students, that "such awards might well be made on a more generous scale; further, they might be given without the irritating inquiry into personal means and individual circumstances".

Reference to the "Notes on Grants Awarded by the Department to Research Workers and Students" (H.M. Stationery Office, 1945. 2*d*.) shows that attention has already been directed to these matters. The amount of the maintenance allowances to students is now £260 a year at Oxford and Cambridge, £250 a year at London, and £220 a year at other universities. When the student lives at home the allowance at all universities is £180 a year. In making the grants no account is now taken of the income of the student's parents; but deductions are made in respect of the student's private income, if any, other awards which may be held by him, and 50 per cent of any demonstrating or teaching fees he may earn. On the other hand, the Department pays all necessary university and college fees, including those for higher degrees. The allowances are also free of income tax. In the case of awards to senior research workers, the amount of the grant depends on the particular circumstances but is not normally less than £400 a year plus approved fees.

Sir Edward Appleton has made reference in several of his addresses mentioned in the article to the very substantial nature of a number of the recent grants made by this Department for the encouragement of fundamental researches at universities of "special timeliness and promise".

O. F. BROWN
(Information Division)
Department of Scientific and Industrial Research,
Park House, 24 Rutland Gate,
London, S.W.7.

Lantern Slides of Diagrams, Formulæ, etc.

THE methods of making lantern slides of text-book figures, etc., described in *Nature*[1] are interesting but unnecessarily ingenious. If a plain glass slide is clean, it can be written on with any ordinary ink in any colour with any pen. Erasures can be made with a penknife. If the finished slide is covered with another and the two are bound in the usual way, the result seems to be as permanent as anything else made of glass.

W. B. YAPP

Exeter College, Oxford.

[1] *Nature*, **156**, 574 (1945); **157**, 591, 700 (1946).

RESEARCH ITEMS

The Yurok

ERIK H. ERIKSON (*Univ. California Pub. Amer. Archæol. and Ethnol.*, **35**, No. 10; 1943) has described the Yurok, and particularly their childhood and "world image". The Yurok are a small tribe of Indians living on or near the Klamath River in northern California, who have occupied this same territory since the earliest times and who have little contact with other tribes. Their interest centred around the river, being mainly concerned with the salmon, and beyond that the men worked with timber and the women with cultivation. They therefore did not have to alter their ways of life drastically with the coming of the white man, as did many other Indian tribes, and for this reason they offer an instructive field of study. The first part of this publication deals with the training and 'medical' practices of a shamaness. Her early experiences were vividly remembered and have been minutely recorded, with the observer's comments. This is followed by a 'creation' story and the description of the ritual attending the erection of a salmon dam. The second part is an instructive account of Yurok children, from birth onwards, with a note on the value of the training in the formation of their character.

Reproduction of the Robin

IN a short article (*British Birds*, **34**, No. 5, May 1946), David Lack describes investigations which show that the British robin rarely breeds in winter. The average clutch increases from early spring until June, after which it declines; the decline occurs slightly later in Germany than England and distinctly later in Scandinavia. Average clutch-size increases from south to north in Europe and also from west to east. The ultimate factor affecting the survival value of clutch-size is considered to be the amount of food which the parents can collect per day for the brood; hence day-length is important, though not the sole factor. The proximate factors affecting the physiology of clutch-limitation are not known; temperature is perhaps important. In completed clutches, about 57 per cent of the eggs laid produce young, but there are marked local variations in hatching and fledging success.

Wildness of Turkeys

A SUBJECT of importance for comprehending the domestication of animals and the survival-rates in the wild has been considered by H. St. Leopold (*Condor*, **46**, 133; 1945). A close analysis has been made of the differences between the wild Eastern American turkey, the domesticated form and hybrids between them. Despite the fact that farm turkeys can roam at will, they have never been known to become wild. Hybrid turkeys have been released in State refuges with little advantage. By field studies, pen trials, and population studies, the author shows that the wildness of turkeys results from a complex of causes inextricably mixed up with the central and sympathetic nervous systems. Anatomical differences between wild and tame turkeys may be of no significance, but the time of development of wattles and caruncles, time of moult, and limited development of secondary sexual characters would appear to be associated with wildness. The wild condition appears to be essential for survival in the free-living population. Reaction to danger and time of mating are self-protective functions. Tranquillity is unsuited to a wild environment. In a hybrid game-farm population the birds are probably heterozygous for wild factors. Although continually back-crossed to wild males, the selection pressure in a confined group would reduce the most wild types. The direction in which a group will evolve depends on whether it is raised in pens or in the wild.

Experimental Cardiac Hypertrophy

A. N. Drury and K. J. R. Wightman (*Quart. J. Exp. Physiol.*, **30**, 45; 1940) produced cardiac hypertrophy in rabbits by establishing a fistula between the carotid artery and the jugular vein. Within three months of the operation the heart weight had approximately doubled. Drury (*Quart. J. Exp. Physiol.*, **33**, 107; 1945) has now shown that this effect is completely reversible. Taking rabbits in which the anastomosis had been present for three months and which X-ray examination showed to have hearts about twice the normal size, he tied off the anastomosis and found that the heart weight returned almost to normal within eight weeks.

Deposition of Air Plankton

FUNGUS spores and pollen grains are deposited in decreasing quantities with increasing distance from a source. P. H. Gregory has examined the mechanics of this dispersal in considerable detail (*Trans. Brit. Mycol. Soc.*, **28**, 26; 1945). Terminal velocities of spores are generally of the order expected for smooth spherical particles from Stokes's law; but several observed deviations are believed to be due to surface roughness or asymmetry. Such velocities, however, only apply to the relatively still air near the ground. For major dispersal it is more appropriate to consider a spore cloud in suspension in the air in process of being diluted by eddies in the course of its transport by wind. Theoretical work by Sutton and practical experiments by Stepanov are combined to give an equation for the coefficient of deposition which should be of considerable value in biological measurements. Practical significance of this view of spore dispersion lies in its emphasis upon the elimination of sources of disease within a crop, rather than to any reliance upon isolation.

Home Production of Onion Sets

ONION sets, so useful in certain types of culture of this crop, have hitherto been imported to Great Britain from regions having a warmer climate. M. A. H. Tincker, F. C. Brown, O. V. S. Heath and M. Holdsworth have recently reported (*J. Roy. Hort. Soc.*, **70**, 5; 1945) that sets can be produced satisfactorily in England. Set production depends on intense competition between closely planted seedlings. The variety 'Ebenezer' appears to be most useful, as it has less tendency than other varieties to flower. Optimum conditions for set production at Wisley involve sowing $\frac{1}{2}$–$\frac{1}{4}$ oz. of seed per square yard on May 12, on plots 1 yard wide, with adequate soil moisture. Careful weeding in the earlier stages of growth is a necessity, and the use of glass covers facilitates the production of small sets. Nitrogenous manuring does not increase the yield. Sets are harvested when mature, thoroughly dried and graded to pass between $\frac{1}{2}$ inch and $\frac{3}{4}$ inch. Tests of such sets at Cockle Park, Northumberland, and Auchincruive, south-west Scotland, have given promising crops.

Microspecies

O. Winge (*C.R. Carls. Lab.*, 23, No. 3) has brought to an end his seventeen years' work on *Erophila*, the microspecies of which interested Lotsy and Bannier. Winge shows that the microspecies of *E. verna* are all sexual and not apomictic. The forms with similar chromosome numbers cross readily. When a cross is made between forms with different chromosome numbers, the F_1 may be partially sterile, but after seven or eight generations numerous fertile forms with different chromosome numbers are obtained. Winge reports 117 types with chromosome numbers of $n = 7$, 12, 15, 16, 17, 18, 20, 26, 32, 29 and 34. Classification according to ecology, chromosome number and geographical distribution reduces the many microspecies of taxonomy to four. He shows that all have arisen by hybridization, and many more are expected to arise. *Erophila verna* therefore is a cœnospecies.

Sorption on Porous Solids

In three papers (*J. Chem. Soc.*, 360, 366, 372; 1945), A. G. Foster, partly with D. N. Broad, describes some results on low-pressure isothermals and the sorption of condensable vapours on porous solids. In the first paper an account is given of a new method of calibrating a Pirani gauge for measuring the pressures of condensable vapours up to 0·5 mm. Sorption isothermals for six vapours on silica and ferric oxide gels are in agreement with Langmuir's theory. In the second paper it is shown that with nine vapours on silica gel the adsorbed amounts at saturation decrease as the diameter of the adsorbed molecule increases. The observed relations can be explained by the existence of tapering capillaries in the adsorbent. Gurwitsch's rule, that the volumes of different liquids adsorbed at saturation are approximately equal for a given adsorbent, is shown not to apply to the cases investigated. An explanation is given. The third paper deals with the adsorption of water and deuterium oxide on three adsorbents, on each of which the relative pressure–volume curves for the two liquids are identical. The results are, on the whole, compatible with the capillary theory of adsorption.

Steel Towers for Transmission Lines

In a paper read by P. J. Ryle in London before the Institution of Electrical Engineers, an empirical formula is derived partly from theoretical considerations, but mainly from practical data, giving the approximate weight of any tower in terms of its height and maximum working overturning moment at the base. The tower weight above ground line is shown to be satisfactorily represented by $kH\sqrt{M}$ tons, where H is the overall tower height above ground line, in feet; M is the overturning moment at ground line, in thousand lb.-ft.; and k is a constant which varies over a range of about 0·0014–0·0029 throughout the whole series of towers; most towers have values of k well within this range. The towers investigated covered ranges of about 16 to 1 in height, 3,000 to 1 in overturning moment, and 1,200 to 1 in tower weight. Design factors which explain variations in the constant k are discussed at some length on a qualitative basis, and it is shown that an economic value for the base width of any tower is in the neighbourhood of $0{\cdot}5\sqrt{M}$ ft. On the assumption that, for any given general type of tower, the total erected cost may be regarded as proportional to the aboveground weight, the tower-weight formula, $kH\sqrt{M}$, can be used with convenience and reasonable accuracy for a wide field of cost estimations, especially those involving comparisons of a number of alternatives of a generally similar nature.

Restriking Voltages

In a paper on the evaluation of circuit breaker restriking voltages by J. R. Mortlock (*J. Inst. Elect. Eng.*, 92, Pt. 2, No. 30, December 1945) it is pointed out that considerable prominence has been given in recent papers before the Institution to the effects of restriking voltages on the performance of circuit breakers; but little guidance has been given to the general determination of these voltages. This paper deals with the approximate evaluation of restriking voltages by the use of equivalent circuits for transformers, generators, etc., and their combination and reduction to a number of standard circuits, the solutions for which are tabulated. The mathematical work involved in any given case has been reduced to routine evaluations. In particular, consideration has been confined to the interruption of 3-phase faults, but the principles can be applied to other types of faults, although these will not give higher voltages.

Origin of the Solar System

F. Hoyle (*Mon. Not. Roy. Astro. Soc.*, 105, 3; 1945) has produced a sequel to an earlier paper (*Proc. Camb. Phil. Soc.*, 20, 256; 1944). In this latter paper he suggested that the solar system originated from a binary star in which one of the components became a nova. The most important requirements that the nova must satisfy are as follows. (*a*) The recoil on the parent star due to the outburst must be sufficiently large to break up the binary system. (*b*) The mass of diffuse gaseous material thrown off in the outburst must be large compared with the mass of the planets, because the high average velocity of expulsion makes it certain that the sun can capture only a small proportion of the total mass thrown off by the star. (*c*) The heating of the diffuse material captured by the sun due to the absorption of radiation from the parent star must not lead to thermal velocities in the material that are greater than the velocity of escape from the sun. The problem is discussed from the point of view of the Crab nebula, the nebulosity of which is believed to arise from the excitation of material thrown off by the super-nova of 1054, the excitation being due to the parent star. Hoyle deals with his assumptions and the observational evidence afforded by the Crab nebula and shows that (*a*) and (*b*) are satisfied. Minkowski has shown that the mass of the diffuse material in the Crab nebula is about fifteen times the mass of the sun, so that there is a large margin of safety in requirement (*b*). Since an appreciable fraction of the mass of the star is thrown off with a velocity of order 1,000 km. per second, an asymmetry of a few per cent in the way in which the material is thrown off in the plane of rotation would be sufficient to satisfy requirement (*a*). The velocity of recoil will be very much less than Hoyle originally supposed, and the time taken for the parent star to recede from the solar system will be much greater than ten days—his previous estimate. The time is now calculated to be about three years, but it is shown that this fulfils requirement (*c*) under certain assumptions.

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, AUSTRALIA

THE eighteenth annual report of the Council for Scientific and Industrial Research*, Commonwealth of Australia, covers the year ended June 30, 1944, and as in the previous year a large part of the total expenditure of £682,849 was incurred in activities devoted to the solution of problems arising out of the War, and to assistance and advice to Government departments, and institutions and organisations concerned with the war effort. The reference to such activities is either confined to brief general statements or omitted entirely. The Council was giving much more attention than formerly to problems of post-war construction, and the work of the Division of Soils, in particular, turned more directly to the needs of land settlement in rural reconstruction. There was a strong demand for soil surveys, as a basic step in considering new areas for sub-division as new farms, and in defining problems of development.

Because of the importance of vegetable investigations, a Committee on Vegetable Problems representing the Division of Plant Industry, Merbein Research Station and the Griffith Research Station was established. The Division of Plant Industry received numerous urgent requests for undertaking weed investigations. Experiments on the control of galvanized burr, a native shrub species that has become a weed on certain natural pastures, were continued. Pasture investigations were also concerned with the control of capeweed, while sixty-four varieties of soya beans have been obtained and are being grown at Canberra, with a view to a programme of trials, selection and breeding, with reference to their value as fodder legumes. Wheat investigations on the influence of plant-food depletion on the damage caused by take-all of wheat continued, and investigations at Stanthorpe concerned with apple and pear root-stocks which have been in progress for ten years were concerned primarily with finding apple root-stocks giving better performance under Australian conditions than the commonly used Northern Spy. Drug plant investigations were largely concentrated on chemical work associated with the investigation of the opium alkaloids and quinine; work on the chemistry of the *Duboisia* alkaloids was practically suspended. The cinchona trees established on the Atherton Tableland did not develop satisfactorily; where not sheltered by adjacent forest, growth was stunted and a high mortality sustained. In vegetable investigation the emphasis was placed on the more important types, such as potatoes, tomatoes, beans, peas, cabbage, carrots, red beet and onions, particularly with reference to the development of suitable varieties for large-scale production and processing. Potato investigations included arrangements for the permanent maintenance and multiplication of the stocks of Up-to-date and Bismarck potatoes free from virus X, which is responsible for considerable losses throughout Australia. Studies of the technique of sampling populations of the aphids that transmit potato virus diseases continued, and experiments on dew- and water-retting of plants showed that providing the ret is stopped at the right time the chief factor determining the quality and quantity of the resultant fibre is the quality of the straw.

Entomological investigations in association with the Army led to important advances in the control of disease-carrying insects; effective methods were evolved for controlling moths in stored, raw and scoured wool; as well as new methods for fumigating bagged and bulk-stored wheat for protection against insect pests. Promising results resulted from intensive investigations on the cattle-tick. Some parasites of the potato moth, the green vegetable bug, and citrus scales imported from overseas have become established in the field. Research on mosquito repellants in Australia and New Guinea confirmed and extended the results obtained previously; by using oils already available in bulk in New Guinea, a blend of distillate, creosote and furnace oil was produced which was as effective as 'Malariol'. The slow knockdown effect of fly sprays containing 0·03 per cent or more of D.D.T. was remedied by adding low concentrations of pyrethrum.

The Division of Animal Health and Nutrition continued work on similar lines to the previous year, and at the MacMaster National Health Laboratory further studies of the effect of phenothiazine on immature forms of *Trichostrongylus* spp. showed that the usual dose was ineffective against immature worms ten to fifteen days old, but that a dose of 40 gm. injected directly into the rumen was effective. Studies of the administration of phenothiazine in a sheep lick indicated that a daily consumption of 0·5 gm. was not so valuable as a single dose of 15 gm. once a month. During the year a joint Department of Soil Chemistry was established to cover the work carried out by the Waite Institute and the Division of Soils; this Department is to undertake the routine testing of the many soil samples collected by the Survey Section, as well as chemical research on specific soil problems. Symbiotic nitrogen fixation continued to be the major subject under investigation by the Bacteriological Department, because it affects pasture practice in South Australia.

During the year, the Division of Forest Products acquired considerable information on the timbers of New Guinea and the surrounding islands, and paid considerable attention to fibre investigations in co-operation with the Wood Chemistry Section, which devoted much of its time to the study of fundamental problems on behalf of the Australian pulp and paper industry. The Section of Timber Physics extended its work of collecting detailed information on the more important physical properties of Australian timbers to material from New Guinea and the Northern Territory. Studies on the preservation of timber indicates that Tego and urea-formaldehyde bonded plywood will not withstand attack by *Nausitora*, although the urea-formaldehyde bonded material appears to be the more resistant. The practicability of impregnating with a hot- and cold-bath treatment plywood bonded with phenol-formaldehyde glue was demonstrated, although plywood bonded with urea-formaldehyde glue gave patchy penetration.

The Division of Food Preservation also continued investigations on problems of direct importance to the war effort. The Division of Fisheries continued its work on similar lines to the previous year, its development activities relating chiefly to the shark oil industry, which is of considerable importance for medicinal (vitamin) oil production, the seaweed industry, chiefly that producing agar-agar, the trawling of fish

* Eighteenth Annual Report of the Council for Scientific and Industrial Research for the Year ended 30th June, 1944. Pp. 78. (Canberra: Government Printer, 1945.) 3s. 4d.

in Tasmanian waters and making tests on methods of catching pelagic fish. A strong publicity policy was developed to reach the trade and fishermen and secure their confidence and co-operation.

The work of the National Standards Laboratory continued to have a purely defence aspect.

Referring to investigations in industrial chemistry, the report states that the Chemical Engineering Section is now well equipped to conduct pilot plant work on several processes developed in the laboratories of the Division. It is anticipated that more and more the Division will turn in future to two main types of projects: first, projects based on problems common to groups of companies or to numbers of industries, such as corrosion, problems connected with the transfer of gases, liquids and solids, with filtration, evaporation and distillation; and projects based upon raw materials with which Australia is well endowed and which are not now used or are not being used to the best advantage. For example, Australia's deposits of zirconia are the most extensive in the world and it is desirable to conduct research work on the chemistry of zirconium compounds and on the properties of zirconium metal and its alloys. The chief investigations in the Biochemical Section were concerned with fellmongery and industrial fermentation, but some work was also carried out on water-vapour permeability, rot-proofing, and the production of butylene glycol by fermentation. The Physical Section was concerned chiefly with the production of titanous powders, the siliconizing of steel, corrosion of metals in ethylene glycol and in glycol-water engine-cooling mixtures and the corrosion of aluminium alloy sheet. In addition to the study of various flotation problems, the Physical Chemistry Section developed a method for determining the molecular weights of lightly condensed resins used in aircraft manufacture. The Organic Section tested numerous silver catalysts for their efficiency for catalysing the oxidation of ethylene to ethylene oxide, and pilot-plant investigations in collaboration with the Chemical Engineering Section were conducted on the manufacture of furfuraldehyde from agricultural waste material. In the Chemical Engineering Section the pilot-plant production of chromic anhydride was undertaken to test a new acid process developed by the Minerals Utilization Section for chromic acid from chrome iron ore. Extensive investigations were undertaken on lubricants and bearings. The Dairy Research Section dealt with problems such as hardened butter substitutes, the oxidation of butter fat, the deterioration of tinned cheese, the keeping quality of milk powder and the fermentation of whey to give lactic acid.

The demands for the services of the Information Section continued unabated, and among the surveys carried out by the Section may be mentioned those of the available data relating to the occurrence and chemical composition of natural gases reported at different times from various parts of the Commonwealth; the isolation of amyl alcohols from the fusel oil residues of the alcoholic fermentation industries and the preparation therefrom of amylene and *p-tert.*-amylphenol; and surveys of methods for the production of vinyl acetate from acetylene, and of the polysulphides of sodium and calcium to assist research projects in the manufacture of synthetic rubber of the thiokol type. Arrangements were completed during the year for the preparation of a revised edition of the "Catalogue of Scientific and Technical Periodicals in Australian Libraries".

SPECTROSCOPIC ANALYSIS

A JOINT meeting of the Physical Methods Group and the Scottish Section of the Society of Public Analysts and other Analytical Chemists was held at Edinburgh on May 23 at which five speakers dealt with various aspects of spectroscopic analysis[1]. This was the third special meeting of this type arranged by the Physical Methods Group of the Society, previous symposia having dealt with polarography and chromatography[2].

Prof. R. A. Morton, in an introductory talk, emphasized the value to the analyst of the modern photo-electric spectrophotometer. One feature of the type of instrument now in use for ultra-violet absorption work is a specially designed electrical circuit for maintaining the light source (a high-intensity hydrogen lamp) at constant output. Measurements made with this apparatus are sufficiently reliable to form the basis of accurate analytical procedures.

As a precise method of analysis, absorption spectroscopy is, in general, limited to those instances where information is available concerning the absorption characteristics of all constituents of the material under examination. It may happen, however, that constituents other than those which it is required to estimate make an unknown and variable contribution to the measured absorption. Prof. Morton and Dr. A. L. Stubbs described a procedure by which a correction can be made to allow for this irrelevant absorption. Providing the absorption measurements can be made with the accuracy which is now attainable with modern equipment, the only assumption that has to be made is that the irrelevant absorption is linear over a selected short range of wave-lengths. The estimation of anthracene in petroleum oils was discussed as a typical instance where the correction procedure may be used. The application of the procedure to the spectrophotometric assay of vitamin A was also discussed at some length. The precise evaluation of the potency of an oil must involve an accurate determination of the absorption at 328 mμ which is unequivocally due to vitamin A. Such a determination must include, in most cases, a correction for irrelevant absorption, since saponification procedure does not always eliminate such absorbing substances. In order to convert the spectrophotometric measurement to international units per gram, a conversion factor is used. These spectrophotometric studies have suggested the most appropriate factors to use, for both corrected and uncorrected absorption measurements.

Chemical analysis by emission spectroscopy is also now attaining its full status as a reliable quantitative procedure. Both branches of spectroscopic analysis have recently shown some notable developments. These were discussed by Mr. B. S. Cooper who, in his paper, described the new apparatus and techniques which have made possible these recent advances. In the field of emission spectroscopy, probably the most important single factor is the development of electrical circuits which enable spectra to be excited with the greatest reproducibility consistent with high sensitivity. In metallurgical applications, an important feature is the study of the optimum conditions for casting and preparing sample electrodes. Another technique now employed is the preparation of a small flat surface on some fabricated part; this forms one electrode while the other is a pointed graphite rod. Photographic aspects discussed included sensitization of plates to the far ultra-violet by coating the emul-

sion with a fluorescent material and the new Kodak plates which have a uniform contrast factor between 2,600 A. and 4,000 A. In some very recent applications, the ultra-violet sensitive multiplier photocell has replaced the photographic plate as the energy receiver; this development is of great significance in connexion with routine quantitative analysis by emission spectroscopy. Some specialized light sources suitable for absorption spectroscopy were also described. These included a high-intensity hydrogen lamp, a multi-component discharge lamp giving many strong lines throughout the ultra-violet, and a tungsten filament source in a special design of glass envelope transparent to 2,700 A. Of interest for general spectroscopic measurements, very high sensitivity thermopiles are now available which may be used in conjunction with a galvanometer deflexion amplifier. Optical materials were also briefly reviewed.

In the discussion following this paper, Mr. G. E. Wilson described a method of converting the anode carbon into a filter stick. Use of this device *in situ* eliminates the necessity of transferring micro-chemical amounts of solid material to the anode crater. The usual micro-chemical filtration technique is used, preferably from a centrifuge tube.

Dr. R. L. Mitchell dealt with the spectrographic methods employed in soil investigations. For the determination of trace constituents in soils, rocks, plant and animal tissues, arc emission, using the cathode-layer technique, is employed, generally in conjunction with a prior chemical concentration of the trace constituents by precipitation with organic reagents such as 8-hydroxyquinoline, tannic acid and thionalide. The photometric technique for quantitative work employs a step sector, blackening curves being drawn for each line measured. The relative intensities of the internal standard and trace element lines are found from measurements made at a constant density, with or without background correction. Errors of this analytical procedure seldom exceed ± 10 per cent for known samples. Practical applications have been to the study of cobalt in soils and plants and its relation to the occurrence of cobalt deficiency in sheep. For the determination of alkalis, alkaline earths, magnesium and manganese in soil extracts and plant materials, the Lundegårdh flame emission method is used. Errors do not exceed about ± 5 per cent for solutions containing 0·1–10 mgm. per 50 ml.

Mr. D. M. Smith contributed a paper on the spectrographic analysis of rare and high-purity materials with particular reference to the control of "Spectroscopically Standardized Substances"[3]. Examples discussed were: (1) the manufacture and control of highest-purity copper electrodes, (2) the use of high-purity carbon and graphite electrodes, and (3) the analysis of rare earths. With these very high-purity materials it is only by a combination of spectrographic and chemical determinations that a reliable estimate of purity can be obtained. Difficulties encountered include the masking of sensitive impurity lines by lines of the basis or other elements, the presence of faint lines of doubtful origin, the enhancement of impurity lines in carbon and graphite electrode materials and the occurrence of spark lines (when using an intermittent A.C. arc) having the appearance of impurity lines. To obtain optimum conditions for the excitation of the spectrum of any given substance, it is necessary to provide a variety of excitation circuits. Various types of sources suitable for analytical purposes were mentioned, including the D.C. arc, the constant-current D.C. arc, the intermittent A.C. arc and the new general purpose source unit which has recently been developed in the laboratories of the British Non-Ferrous Metals Research Association.

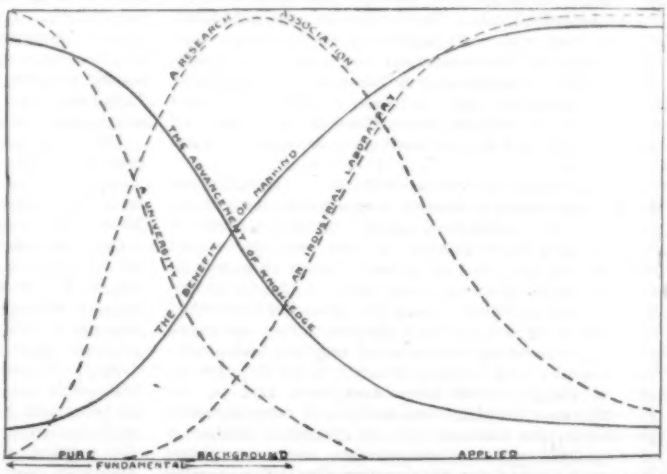
In the discussion following this paper, reference was made to the desirability of having a conditioned atmosphere in the spectrographic laboratory used for analysis of the highest-purity materials. Examples were quoted of the intrusion of airborne impurities from neighbouring premises.

The general impression given by the papers and discussions was that the methods of emission and absorption spectroscopy, as applied to chemical analysis, have now attained their full status as reliable quantitative procedures.

[1] These papers will be published in the *Analyst*.
[2] See *Nature*, **157**, 487 (1946).
[3] See *Nature*, **155**, 784 (1945).

CO-OPERATIVE RESEARCH

ONE of the most outstanding industrial developments in Great Britain during the last generation has been the establishment and rapid expansion of the research association. Some idea of the growth of co-operative research in Great Britain will be gathered from the fact that the expenditure of all the research associations has shown an increase during the last ten years from £300,000 to more than a million pounds a year. On April 27, Sir Charles



FULL LINES SHOW THE TWO PRINCIPAL OBJECTIVES OF RESEARCH AS FUNCTIONS OF THE VARIOUS RESEARCH ACTIVITIES OF SCIENTIFIC MEN. BROKEN LINES SHOW DISTRIBUTION OF EFFORT IN SOME TYPICAL RESEARCH ORGANISATIONS

Goodeve, director of the newly formed British Iron and Steel Research Association, discussed before the Newport Metallurgical Society the function of such organisations and their relationships with the industry concerned on one hand, and other research institutions, such as the universities and the National Physical Laboratory, on the other. Although his remarks were concerned directly with the iron and steel industry, they are of importance in a very much wider field.

The research organisation in any industry is divisible into three parts: competitive research in special products, co-operative research, and independent academic research; and the interrelation of these is a matter of fundamental importance. All the major industries of Britain have well-equipped and staffed research and design laboratories, some of which are outstanding. There is also great strength on the academic side, although here, as in many other directions, we are faced with the need for considerable expansion.

Sir Charles's conception of this inter-connected system is illustrated in the accompanying diagram presented at a conference on Scientific and Industrial Research held during December 7–8 by the British Association for the Advancement of Science. The abscissæ in this diagram represent the activities of scientific workers laid out in order, from pure science on the left to fully applied on the right. The principal objective of university laboratories is "the advancement of knowledge", that of research in industrial laboratories is primarily for "the benefit of mankind". The research association, therefore, lies in a midway position concerned primarily with background or objective research, with new techniques, and processes of common interest. It will prefer to support fundamental research in the universities rather than do such work in its own laboratories, unless there are special reasons to the contrary. It will, in general, expect the firm's own laboratories to carry out the later technical developments, works' investigations, etc.

From the diagram it will be seen that there is no sharp line of demarcation between the work of the three types of organisation: it is, in fact, extremely desirable that there should be a considerable overlapping of function. That the extension of co-operative research does not reduce the need for research laboratories in the individual works is now well recognized; indeed, this need is increased. It is obviously extremely important to the national economy of Britain that we should somehow arrange that the present enormous time-lag between the discovery of new knowledge and its application should be greatly reduced. The three types of organisation should, therefore, act in series, not in parallel, and the setting up of the research associations should in large measure eliminate the bottle-neck in the middle. Unless, however, works' laboratories are also functioning efficiently, we may run into a further serious bottle-neck at the end of this chain, when the application of research is beginning to produce commercial results.

This general policy is in accordance with one of the greater lessons of the War and of government research in peace-time, namely, that over-centralized research suffers from a great many disadvantages which may more than offset the advantage of simplified administration. All existing research facilities should play their part, mutually supplementing each others' contribution.

Another very important side of a research association's activities is in providing a mechanism whereby the brains of all those in an industry can be applied to the benefit of that industry as a whole. It is a difficult problem which requires continuous study, but one the solution of which is of great importance. Committees and sub-committees provide one channel through which the members can make this general contribution, and the frank and open discussions which take place in those connected with the iron and steel industry are evidence of the general willingness to co-operate. The goal to be aimed at is one where every man in the industry should feel that he is an integral part of the whole, able and willing to put forward his ideas for the general benefit of the industry concerned. F. C. T.

THE PHREATOICOIDEA, A GROUP OF ISOPOD CRUSTACEANS

A DETAILED monographic revision of the Phreatoicoidea, a sub-order of Isopods, running to more than 300 pages of text and illustrations, appears in the *Papers and Proceedings of the Royal Society of Tasmania* for the years 1942 and 1943 (published in 1943–44). The author, Prof. G. E. Nicholls, of the University of Western Australia, points out that the first detailed description of a member of this group of Crustacea appeared in 1894, and since that time many additional species have been discovered. The Phreatoicoidea, it may be added, are of considerable phylogenetic interest and importance. They are regarded by some authorities as connecting the Isopod with the Amphipod Crustacea.

Two families are recognized, namely, the Amphisopidæ and the Phreatoicidæ, which are separable on the presence or absence of a lacinia mobilis in the mandibles. The Amphisopidæ range from north Australia to Victoria and Tasmania and are also found in parts of South Africa. While the majority of the species are found in cold freshwaters, some of them are unusual in their choice of habitat. Thus, one species occurs in steaming hot water issuing from deep artesian borings, a blind and wholly subterranean species is found in West Australia, and semi-terrestrial burrowing forms are met with in Tasmania. Altogether twelve genera are recognized as belonging to this family, five of them being described for the first time.

In the Phreatoicidæ, some thirty-odd species and subspecies are regarded as being valid, and the original genus *Phreatoicus* is divided up into nine other genera all of which are described as new. Also more than twenty of the species are described for the first time. The family is more restricted in its geographical range than the Amphisopidæ, being confined to the Bassian region of Australia and to New Zealand.

The monograph concludes with a supplementary note on the genus *Acantho telson*, the systematic position of which is uncertain. Previously it has been regarded as belonging either to the Syncarida, or to the Amphipoda, or as occupying a position intermediate to the Amphipoda and Isopoda. The author considers that although it has Syncaridan affinities, its true position is with the Phreatoicoidea.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Friday, July 5

PHYSICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Demonstrations and Scientific Papers.

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. A. T. Marston: "Piltdown Man, with Special Reference to the Ape Mandible and Canine Tooth".

Friday, July 5—Saturday, July 6

INSTITUTE OF PHYSICS, INDUSTRIAL SPECTROSCOPIC GROUP (at the Wellcome Research Foundation, 183 Euston Road, London, N.W.1).—Conference on "Industrial Spectroscopy".*

Friday, July 5

At 2.30 p.m.—"Infra-red Absorption Spectroscopy" (Speakers: Dr. H. W. Thompson and Mr. G. F. Lothian).

Saturday, July 6

At 10 a.m.—"Emission Spectroscopy" (Speakers: Mr. Nickelson, Mr. A. Walsh and Mr. H. T. Shirley).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURERS (2) IN ENGINEERING—(*a*) with good honours degree in Engineering and some practical experience, including surveying, (*b*) with good honours degree in Engineering and considerable practical experience, preferably in municipal engineering—The Secretary, The University, Aberdeen (July 5).

LECTURER IN CIVIL ENGINEERING—The Registrar, The University, Manchester 13 (July 8).

DEPUTY PUBLIC ANALYST—The Town Clerk, Southwark Town Hall, Walworth Road, London, S.E.17, endorsed 'Deputy Public Analyst' (July 8).

LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING—The Secretary and Registrar, The University, Bristol (July 8).

ASSISTANT BOROUGH ANALYST AND DEPUTY GAS EXAMINER—The Town Clerk, Civic Centre, Southampton, endorsed 'Assistant Borough Analyst' (July 8).

AGRICULTURAL ECONOMISTS to the Governments of the Gold Coast and Nigeria—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting G.19699 (July 10).

ASSISTANT LECTURERS (2) IN THE DEPARTMENT OF ZOOLOGY—The Secretary, University College, Gower Street, London, W.C.1 (July 15).

ASSISTANT LECTURER IN AGRICULTURAL BOTANY, and an ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY—The Principal, Royal Agricultural College, Cirencester, Glos. (July 15).

CHAIR OF BACTERIOLOGY AND IMMUNOLOGY tenable at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 17).

ASSISTANT LECTURERS (2) IN PHYSICS—The Secretary, University College, Gower Street, London, W.C.1 (July 20).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Sheffield (July 31).

SENIOR EXPERIMENTAL OFFICER, and EXPERIMENTAL OFFICER, at the Atomic Energy Research Department, Harwell—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1530 (August 1).

DEMONSTRATOR IN CHEMISTRY—The Registrar, Queen Mary College, Mile End Road, London, E.1 (August 15).

CHAIR OF CIVIL AND MECHANICAL ENGINEERING AND APPLIED MECHANICS—The Secretary, Royal Technical College, Glasgow (August 31).

LECTURER IN MATHEMATICS—The Secretary, Queen's University, Belfast (September 7).

PROBATIONARY ASSISTANT ENGINEER (male) in the Engineering Department of the Post Office—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1501 (October 1).

CHIEF SCIENCE MASTER to teach CHEMISTRY up to Higher Certificate and University Scholarship standard in the King Edward VII School—The Director of Education, Education Office, Sheffield 1.

LECTURER IN MATHEMATICS, and a LECTURER IN ENGLISH (in Pietermaritzburg), a LECTURER IN PSYCHOLOGY, and a LECTURER IN POLITICAL SCIENCE AND PUBLIC ADMINISTRATION (in Durban), at the Natal University College—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

LECTURER IN BOTANY, to take classes in Botany to B.Sc. (General) standard and Biology to Intermediate Science standard—The Clerk to the Governing Body, Northern Polytechnic, Holloway, London, N.7.

LECTURER IN CHEMISTRY—The Registrar, University College of the South-West of England, Exeter.

LECTURER IN APPLIED PHYSIOLOGY—The Dean, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1.

ASSISTANT LECTURER IN ZOOLOGY, and a STEWARD/DEMONSTRATOR IN BOTANY—The Secretary, Wye College, Ashford, Kent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 50, Section A, No. 12: Production and Annihilation of Negative Protons. By the Rev. James McConnell. Pp. 189–222. 2*s.* Vol. 50, Section A, No. 13: Infinitesimal Affine Connections with Twofold Einstein-Bargmann Symmetry. By Friedrich Mautner and Erwin Schrödinger. Pp. 223–232. 1*s.* Vol. 50, Section B, No. 15: Investigations on Marsh Spot Disease in Peas. By Thomas Walsh and Stephen J. Cullinan. Pp. 279–286. 1*s.* Vol. 50, Section B, No. 16: The Effect on Plant Growth of Substituting Strontium for Calcium in Acid Soils. By Thomas Walsh. Pp. 287–294. 1*s.* Vol. 50, Section B, No. 17: Tables to Illustrate the Geological History of Species-Number in Diatoms. By James Small. Pp. 295–310. 2*s.* Vol. 50, Section B, No. 18: Plankton Algæ from North-Western Ireland. By E. M. Lind and W. H. Pearsall. Pp. 311–320. 1*s.* Vol. 50, Section B, No. 19: River Liffey Survey, 6. Discussion on the Results obtained from Investigations on the Food and Growth of Brown Trout (*Salmo trutta* L.) in Alkaline and Acid Waters. By Winifred E. Frost. Pp. 321–342. 1*s.* 6*d.* Vol. 50, Section B, No. 20: The Synthesis of Physiologically Active Amines. Part 2. The Action of Trimethylamine on the Oxides of Phenyl Styryl Ketones. By Joseph Algar and Peter G. Sherry. Pp. 343–348. n.p. Vol. 50, Section B, No. 21: A Galactan Sulphuric Ester from *Dilsea edulis*. By Vincent C. Barry and Thomas Dillon. Pp. 349–358. 1*s.* Vol. 50, Section B, No. 22: Iron Deficiency in Tomato Plants grown in an Acid Peat Medium. By Thomas Walsh and Edward J. Clarke. Pp. 359–372. 1*s.* (Dublin: Hodges, Figgis and Co., *Ltd.*; London: Williams and Norgate, Ltd., 1945.) [1812

British Empire Cancer Campaign. Twenty-second Annual Report, 1945. Edited by J. P. Lockhart-Mummery. Pp. 102. (London: British Empire Cancer Campaign, 1945.) [1912

Conference on Nature Preservation in Post-War Reconstruction. Memorandum No. 6: Natural History Survey of Great Britain. National Nature Reserves and Conservation Areas in England and Wales. Report by the Nature Reserves Investigation Committee. Pp. iv + 79. (London: Society for the Promotion of Nature Reserves, c/o British Museum (Natural History), 1945.) 3*s.* [1912

Other Countries

U.S. Department of the Interior: Geological Survey. Bulletin 940-E: Occurrence of Manganese in Eastern Aroostook County, Maine. By Walter S. White. (Strategic Minerals Investigations, 1943.) Pp. iv+125–162+plates 24–28. 25 cents. Bulletin 940-F: Manganese Deposits of the Lyndhurst-Vesuvius District, Augusta and Rockbridge Counties, Virginia. By Maxwell M. Knechtel. (Strategic Minerals Investigations, 1943.) Pp. iv+163–198+plates 29–34. n.p. Bulletin 940-G: Manganese Deposits of the Sweet Springs District, West Virginia and Virginia. By Harry S. Ladd. (Strategic Minerals Investigations, 1943.) Pp. iii+199–218+plates 35–36. 35 cents. Bulletin 940-H: Manganese Deposits of the Flat Top and Round Mountain Districts, Bland and Giles Counties, Virginia. By Harry S. Ladd and Frank W. Stead. (Strategic Minerals Investigations, 1943.) Pp. iv+219–246+plates 37–41. 75 cents. Bulletin 940-J: Cobalt-bearing Manganese Deposits of Alabama, Georgia and Tennessee. By W. G. Pierce. (Strategic Minerals Investigations, 1943.) Pp. iv+265–286+plates 48–55. 20 cents. Bulletin 941: Geology of the Coastal Plain of Georgia. By C. Wythe Cooke. Pp. vi+121+1 plate. 1.25 dollars. Bulletin 944-A: Phosphate Deposits of the Teton Basin Area, Idaho and Wyoming. By Louis S. Gardner. (Contributions to Economic Geology, 1943–44.) Pp. iii+36+4 plates. n.p. (Washington, D.C.: Government Printing Office, 1943–1944.) [111

U.S. Department of the Interior: Geological Survey. Bulletin 945-A: Geology of the Grey Eagle and some nearby Chromite Deposits in Glenn County, California. By G. A. Rynearson and F. G. Wells. (Strategic Minerals Investigations, 1944.) Pp. iv+22+6 plates. 50 cents. Bulletin 945-B: Chromite Deposits near San Luis Abispo, San Luis Obispo County, California. By Clay T. Smith and Allan B. Griggs. (Strategic Minerals Investigations, 1944.) Pp. iv+23–44+plates 7–15. 60 cents. Bulletin 945-C: Beryllium and Tungsten Deposits of the Iron Mountain District, Sierra and Socorro Counties, New Mexico. By Richard H. Jahns; with a Section on the Beryllium Minerals, by Jewell J. Glass. (Strategic Minerals Investigations, 1944.) Pp. iv+45–80+plates 16–31. 1.25 dollars. (Washington, D.C.: Government Printing Office, 1944.) [111

State of Illinois: Department of Registration and Education, Natural History Division. Available Publications of the Illinois Natural History Survey. Pp. ix+20. (Urbana, Ill.: Illinois Natural History Survey, 1945.) [611

An Arithmetical Approach to Ordinary Fourier Series. By Aurel Wintner. Pp. 29. (Baltimore, Md.: The Author, Johns Hopkins University, 1945.) [611

Development and Welfare in the West Indies. Bulletin No. 7A: Forestry in the Leeward Islands—The British Virgin Islands. Report by the Conservator of Forests, Trinidad and Tobago, after Preliminary Visit by J. S. Beard, Assistant Conservator. Pp. 16. (Bridgetown, Barbados: Advocate Co., Ltd., 1945.) 5 cents. [611

Bulletin of the American Museum of Natural History. Vol. 86, Article 1: Supraspecific Groups of the Pelecypod Family Corbulidæ. By Harold E. Vokes. Pp. 32+4 plates. (New York: American Museum of Natural History, 1945.) [611

U.S. Department of Agriculture. Technical Bulletin No. 896: Biology of the Tobacco Hornworm in the Southern Cigar-Tobacco District. By A. H. Madden and F. S. Chamberlain. Pp. 51. (Washington, D.C.: Government Printing Office, 1945.) [611

Scientists of Tomorrow. Essays of the Winners of the Westinghouse Science Scholarships in the Fourth Annual Science Talent Search, 1945. Pp. vi+136. (Washington, D.C.: Science Clubs of America, Science Service, 1945.) [611

Geological Survey Department, Nigeria. Annual Report, 1944. Pp. 16. (Lagos: Government Printer; London: Crown Agents for the Colonies, 1945.) 1*s.* [2211

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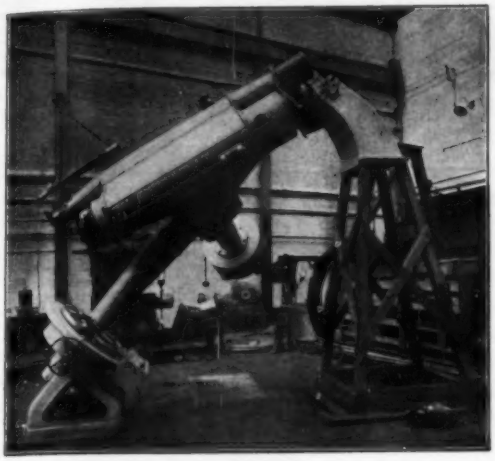

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The University Staff consists of 64 Professors, over 150 Readers and Lecturers, and 120 Assistants and Demonstrators. Facilities are afforded for research in scientific and other subjects.

Further information regarding Matriculation, Scholarships, etc., may be obtained from the Secretary.

W. A. FLEMING,
Secretary to the University.

COMMONWEALTH OF AUSTRALIA

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DIVISION OF TEXTILE RESEARCH

Applications are invited for appointment to the position of Chief of the Division of Textile Research which is now in process of formation. The headquarters of the division will be in Victoria. The Chief will be responsible to the Executive Committee of the Council for the initiation and development of all aspects of the research programme, both fundamental and technological. The salary will be £2,000 p.a. (nominal). In addition, a cost-of-living allowance, at present amounting to £40 p.a., will be paid. General experience indicates that the cost of living in Australia in terms of £A1 is approximately equivalent to the cost of living in England in terms of £1 sterling. Details, however, would be obtainable from the undersigned. Subject to a satisfactory medical examination, the appointee will be eligible to contribute to, and receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Fund.

Applications giving particulars of qualifications and experience, together with references to published results of scientific work, should reach the undersigned not later than July 27, 1946.

LEWIS LEWIS,
Secretary,
Australian Scientific Research Liaison Office,
Australia House, Strand, London, W.C.2.

PORTSMOUTH MUNICIPAL COLLEGE

PRINCIPAL: L. B. BENNY, M.A.

ENGINEERING DEPARTMENT

HEAD OF DEPARTMENT:
R. A. MORRIS, M.Sc., B.A., A.M.I.MECH.E.

Applications are invited for the post of Lecturer in Mechanical or Civil Engineering, from persons suitably qualified to teach to the standard of the B.Sc. engineering degree.

Particulars and forms of application may be obtained from the Registrar, the Municipal College, Portsmouth.

E. G. BARNARD, M.A.,
Chief Education Officer.

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There are vacancies in the Electrical Engineering Department on the side of electrical machine and power for one Lecturer and one Assistant Lecturer. The salary of the Lecturer will be from £500 to £700 per annum and of the Assistant Lecturer £350 to £400 per annum and with the usual F.S.S.U. superannuation, both according to qualifications. The appointment for the Assistant Lectureship is for a period of three years. An honours degree and some practical experience of heavy electrical engineering are essential in both cases.

Applications, accompanied by a full statement of qualifications, and with references, should be sent to the Head of the Electrical Engineering Department, City and Guilds College, Exhibition Road, London, S.W.7, by Wednesday, July 17, 1946.

SUNDERLAND EDUCATION COMMITTEE

THE TECHNICAL COLLEGE

PRINCIPAL: D. A. WRANGHAM, M.Sc., SEN.WH.SC., D.I.C., M.I.MECH.E., A.C.G.I.

Applications are invited for the post of full-time lecturer in Physiology and Zoology. Candidates should possess a degree in physiology and have some qualification in zoology. Previous teaching experience is desirable but not essential. The day courses prepare for the M.P.S. and Ph.C. qualifications of the Pharmaceutical Society of Great Britain. Day and evening students also prepare for the degrees of B.Pharm. and B.Sc. of the University of London. Salary in accordance with the Burnham (Technical) Scale.

Further particulars and form of application may be obtained from the Registrar, The Technical College, Sunderland. Applications must reach the undersigned not later than Saturday, July 13, 1946.

R. E. HERON,
Acting Director of Education.

Education Offices,
15 John Street, Sunderland.

ADDENBROOKE'S HOSPITAL CAMBRIDGE

Applications are invited for the full-time posts of Senior and Junior Physicists to the Radiotherapeutic Centre. The salaries will be at the rate of: Senior £700-£50-£1,000 per annum; Junior £450-£25-£600 per annum. For candidates with good experience the commencing salary will be fixed at a suitable level within the quoted ranges. The persons appointed will also be attached to the Radiotherapeutic Departments at the East Suffolk and Ipswich Hospital and the Norfolk and Norwich Hospital and travelling expenses to and from these hospitals will be allowed. The physicists will be required to make their headquarters in Cambridge as the allocation of duties to that centre will not be less than half-time. Superannuation benefits of the Federated Superannuation Scheme for Nurses and Hospital Officers will be available.

Applications giving age and full particulars of experience, together with copies of not more than three testimonials, should be sent to the undersigned not later than July 10, 1946.

J. A. BEARDSALL,
Secretary-Superintendent.

THE VETERINARY EDUCATIONAL TRUST

ELECTION TO A B.O.C.M. FELLOWSHIP

Applications are invited for the appointment to the above Fellowship from any person who, on October 1, 1946, is under 36 years of age and has taken the Membership Diploma of the Royal College of Veterinary Surgeons or a degree in any Faculty in any University in the British Empire; or who, if a female, has passed an examination which would have entitled her if a male to take any such degree.

The Fellowship is to be awarded for research in animal nutrition, particularly for work connected with one of the following species: Bovine, Ovine, Porcine, or the Domestic Fowl. The Fellowship is intended for a graduate of some research experience and will be of the value of £500 per annum (liable to income tax). It will be tenable for one year in the first instance and may be extended to two and in rare instances to three years at the discretion of the Advisory Committee.

The election will be made on August 12, 1946, and will take effect as from October 1, 1946. Applications must be received on or before Monday, July 15, 1946. Forms of application are obtainable from: Dr. W. R. Wooldridge, M.Sc., M.R.C.V.S., Scientific Director for the Veterinary Educational Trust, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

COUNTY BOROUGH OF WEST HAM

EDUCATION COMMITTEE

WEST HAM MUNICIPAL COLLEGE, ROMFORD ROAD, STRATFORD, E.15

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Form of application and particulars may be obtained from the Principal on receipt of a stamped addressed envelope and should be returned to him not later than Saturday, July 6.

IRVINE G. JARDINE,
95 The Grove, Stratford, E.15. Education Officer.

UNIVERSITY OF ABERDEEN

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The University Court will shortly proceed to the appointment of two Lecturers in Engineering, as under: (a) Candidates will require to have a good honours degree in engineering and some practical experience, including surveying. Salary £400-£500 according to qualifications and experience. (b) Candidates will require to have a good honours degree in engineering and considerable practical experience, preferably in municipal engineering. Salary £500-£650 according to qualifications and experience.

Persons desirous of being considered for the office are requested to lodge their names with the Secretary to the University by July 5, 1946. Conditions of appointment and form of application may be obtained from the undersigned.

H. J. BUTCHART,
University of Aberdeen. Secretary.

ROYAL AGRICULTURAL COLLEGE

CIRENCESTER, GLOS.

Applications are invited for the following posts. The salary in each case will be £400 per annum, with board-residence. The men appointed will be required to live in College, and to take up their duties on September 1, 1946.

(1) Assistant Lecturer in Agricultural Botany. Candidates should have a degree in Agriculture or Science (preferably an Honours Degree in Agricultural Botany).

(2) Assistant Lecturer in Agricultural Chemistry. Candidates should preferably have an Honours degree in Agricultural Chemistry, or Chemistry with biochemistry, and will be required to lecture on Animal Nutrition.

Applications, with copies of two testimonials, should reach the Principal not later than three weeks after the appearance of this advertisement.

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CITY OF CARDIFF EDUCATION COMMITTEE

THE TECHNICAL COLLEGE

PRINCIPAL: A. HARVEY, PH.D., B.Sc., F.INST.P.

Applications are invited for the following full-time posts, duties to commence September, 1946: (1) Lecturer in Physics. Candidates should possess an Honours Degree, or its equivalent, and Industrial research or teaching experience would be a recommendation. (2) Lecturer in Biology. Candidates should be well qualified in Botany and Zoology.

In each case the salary will be in accordance with the appropriate Burnham scale. Forms of application are obtainable from the undersigned to whom they should be returned as soon as possible.

W. J. WILLIAMS,
City Hall, Cardiff. Director of Education.

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